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RAIL CIRCUITS AND TREATED TIES.

The report that a well-known road which is planning to build a timber preserving plant is hesitating about adopting a zinc-chloride process through fear of trouble to the track circuits of automatic signals, is drawing attention anew to a phenomenon first observed several years ago, and noted in these columns at the time. In view of the present interest in the matter and of the fact that most people have forgotten the investigation referred to, it seems worth while to give again the essential points reported at that time.

The investigation was made by V. I. Smart, then signal inspector of the Illinois Central. The trouble is, of course, caused by the greatly increased conductivity of a zinc-treated tie. By introducing enough of these ties, the leakage between rails becomes so great that there is not enough current to hold the relay. As this leakage is directly proportional to the number of ties in track, a temporary reduction in the length of the section relieves the trouble by increasing the resistance between rails. The trouble disappears after a time, when the section may again be extended to its original length. The reason for the disappearance of the trouble after the track circuits have been working for a while was explained in the report. The ties lose in conductivity, because the electric current causes electrolysis of the zinc solution (ZnCl, HO). "The Cl is freed at the positive pole, which in this case is one of the iron spikes holding the rail to the tie. Zn is deposited at the other spike, the negative pole. The Cl enters into combination with the H in HO, forming HCl, or hydrochloric acid. This attacks the iron of the spike, producing FeCl, or chloride of iron, which is deposited on the spike, or rather between the spike and the wood of the tie, in greenish-blue, hydrated crystals. This deposit of chloride of iron offers sufficient resistance to the weak track circuit to reduce the conductivity of the tie to such an extent that the track section may be lenghened considerably without trouble to the relay reappearing." It is therefore suggested that where track circuits are to be installed in conjunction with a large number of such ties, trouble to the signal circuit may be obviated by putting several cells of the battery in series on the track for some time before the signals are put in service in order to insulate the spike in the manner described; but care must be taken not to change the polarity of the rails afterward. It must be remembered, also, that the trouble will return if the spikes on the positive rail are renewed, since the presence of the FeCl crystals is essential to successful working.

The foregoing, as it specifically states, applies only to the use of a large number of these ties. For ordinary renewals—12 to 15 per cent. a year, and even up to 25 per cent.—there seems to be no trouble. In addition to the effect already described, signal engineers claim recently to have established the fact that there is a storage battery effect from these ties, but that it does not interfere with the working of the circuits under the renewal conditions mentioned. It is reported that on long circuits—4,000 ft. or over, say—where there are a good many of these ties in track, there is considerable leakage. But track circuits of this length are uncertain in their operation under any circumstances and need to be shortened where possible. We understand that on the Santa Fe, which was perhaps the largest user of zinc-treated ties in the country until its recent change to the creosote process, the track circuits were reduced to a maximum of half a mile.

There seems to be apprehension in some quarters that creosoted ties, as well as zinc-treated ties, will have a bad effect on the track circuits; in fact, some signal men claim to have had experience proving that creosoted ties act as partial conductors, and they say that a sufficient number will cause a short circuit. There seems to be no reliable data on the subject, however. On one of the Southern Pacific lines a few tests were made of untreated ties, of zinc-chloride, and of creosote-treated ties, to determine their relative resistances. There was such a wide variation in results, however, under apparently like conditions, that it was not considered safe to draw any conclusion but the very general one that the resistance of the zinc-treated tie is considerably less than that of the creosoted or of the untreated tie. At the 1907 convention of the Southwestern Electric and Gas Association, its president vouched for the fact that creosoted poles are good conductors. He stated that in Galveston, Tex., where they are compelled to use creosoted poles because of the soil conditions, the linemen have a practice of mounting and dismounting from the poles with a jump so as not to have a spur in the pole and a foot on the ground at the same time.

One signal engineer who was asked about his experience with treated ties responded that he was having far more trouble from the brine from refrigerator cars. This long-standing trouble the signal men share with the bridge men. The only effective remedy is one

such as a committee of the Superintendents of Bridges and Buildings recommended at the last convention, namely, that instead of allowing the brine to drip on the track it should be caught in a receptacle to be emptied at intervals by the trainmen. We understand that a committee of the Signal Association now has the subject in hand for the collection of data and report. It is interesting to note, in this connection, that trouble was experienced with the track circuits on the trestles on the Ogden-Lucin cut-off across Great Salt Lake from salt water dashing over the track and wetting the tops of the ties. During a quiet period, when the ties were dry, they were given a coating of crude oil on top, which ended the difficulty.

NEW RAILROAD BUILDING.

The fourteenth regular Construction Record of the *Railroad Gazette* is published in this issue. This comprehensive list of railroad construction work was compiled semi-annually from the spring of 1898 until March, 1902, when it was made an annual record.

A change of policy in its compilation has this year been carried out. In earlier years the list included, besides lines on which work was actually under way, projects not yet undertaken and new companies incorporated since the previous Construction Record was issued; it was, in short, a complete summary in condensed form of all the information printed during the year in our railroad construction columns. This sort of a record, though complete, contained many companies which never had built, and, as experience proved to us, never would, build a mile of railroad. This year the aim has been to list only such work as is actually being carried out or which there is strong likelihood will soon be undertaken. A very large majority of the items in this year's Construction Record—probably as large a proportion as 95 per cent.—are made up of official information sent us. The small proportion remaining is made up of projects on which we know work is under way, projected lines of companies which built railroad last year and seem likely to carry on construction, and a very few projects of large railroads which, although they are not likely soon to be undertaken, are so important in showing the direction of their future expansion, that they should be included in the record. By following out this policy the length of the Construction Record has been reduced but its convenience and value greatly increased. The list has been prepared with great care, by experienced men, under an improved system for securing official information. It is, we believe, the best summary in existence of actual railroad construction in America.

This record of new railroad construction accurately reflects the present financial and industrial conditions. Not a single new project of large importance has recently been undertaken. Certain important companies operating thousands of miles of line do not appear in the record at all. Many of the larger railroads which are included in the list are simply finishing small improvements or extensions which were begun a year or more ago. The big undertakings in the United States, the extension of the Chicago, Milwaukee & St. Paul to the Pacific coast, the Western Pacific, the Denver, North-Western & Pacific and the Spokane, Portland & Seattle which is the new name of the Hill low grade line down the north bank of the Columbia river to Portland, were already begun back as far as 1905 or earlier, and have to be carried on to completion in order to make the already large investments profitable.

The hard times have, however, brought one important advantage to those companies which have funds on hand for carrying on extensions and improvements. During 1906 and the first half of 1907 construction work was carried on at the largest expense both for labor and materials ever known. Now prices have gone down and large savings accrue as compared with the cost of construction a year ago. President Earling, of the St. Paul, estimates that present costs of labor and materials are fully 30 per cent. less than those which prevailed when work was begun on the extension in 1905 and 1906.

But this is small comfort to the average railroad. For lack of credit almost all of even the strongest railroads have reduced construction expenditures to the lowest possible minimum. The present situation of a road like the Southern Railway is particularly unfortunate. A little more than a year ago its tracks and yards were literally swamped with traffic. One yard at the junction of a through main line and a branch line was so full that for days more than 100 cars were stored on the main line of the branch and had to be shifted on to the through main line and back for every branch line train. Per diem and penalties on many cars more than ate up the freight charges. To-day, when all is changed and there is little traffic, is the time that a large campaign of double tracking and yard enlargement should be undertaken and pushed to completion with all possible speed. But the Southern neither has any funds nor can secure them for such work.

North of the Canadian boundary line the outlook is different. Although even there construction plans have been modified by the present financial situation, the large undertaking of the Grand Trunk Pacific, backed by the Dominion government, for a new line from ocean to ocean, is being fast advanced, and important extensions and improvements are being continued by the Canadian Pacific. A great deal of progress has been made by the Grand Trunk Pacific during the year, not only in the complete location of its 3,550 miles of line, but in laying more than 500 miles of track, 100 miles on the Lake Superior branch, from Winnipeg, Man., to Fort William, Ont., and 415 miles from Portage La Prairie, Man., to Saskatoon, Sask. The Canadian Northern was not so active during 1907, and is going more slowly than in recent years in its plans for extensions.

In Mexico also there is extensive work under way. The Southern Pacific forces are pushing construction of a line south along the west coast of the Republic, which, when completed, will connect the United States boundary, over the Sonora Railway, with Guadalajara, state of Jalisco, Mex., nearly 1,000 miles south. Now that the merger of the principal Mexican roads has been formally carried out, it is probable that certain important pieces of new construction, which have been postponed while the merger negotiations were pending, will shortly be undertaken and carried through, the most important of these being the construction of a cut-off which will furnish a direct line between the city of Mexico and the very important port of Tampico and be less than one-third as long as the Mexican Central's present route.

RAILROAD TRACK TANKS

Although track tanks have been a feature of railroad operation for 50 years, and have been used in America for nearly 40 years, there is little published information on the subject, at least in this country. This is doubtless due principally to their limited use, since at present there are only seven or eight roads, all eastern lines, which have them. But although comparatively few in number, they have been developed and improved wonderfully, so that the track tank installation of to-day is an elaborate and expensive plant as compared with its prototype of a generation ago. Hence the article on another page, which describes present practice, especially as found on the Lake Shore, presents much that is new, and brings the record up to date.

A feature of special interest in that article is the record of scooping tests, graphically shown. Data thus obtained gives information on three essential points: The efficiency of the design of the scoop, its correct adjustment, and the most effective scooping speeds. The importance from the money standpoint of having these right is referred to in the article. An interesting point is suggested by these records: Each road has its own design of scoop and it is fair to assume that they are not all equally efficient. Tests of this character for all designs would enable their relative efficiencies to be determined and would suggest improvements in the less efficient designs that might mean a material saving in operating costs.

Another interesting point is the evolution in trough dimensions and the reasons the Lake Shore has for preferring a trough 28 in. wide, 7½ in. deep and 2,000 ft. long. The Pennsylvania once experimented on its Philadelphia division with a trough 29 in. wide, but the results were unsatisfactory and no change was made from the standard of 19 in. Trains running at ordinary speeds wasted more water and received less than with the standard trough. To correct this, flanges were put along the top of the trough extending inwardly so that the opening provided for the scoop was about the same as with the standard trough. This put more water into the locomotive tank than the standard trough but also wasted more. It was decided from these results that any saving in water would have to be made by a modification of the scoop, rather than of the trough. The experiments included the placing of deflectors on each side of the scoop, but they did not reduce the waste appreciably and were objectionable because they impeded inspection and repairs to the scoop details.

While track tanks are installed primarily for passenger service, some of the lines having them consider it almost as essential to water freight trains from them as well, since this expedites all train movement, particularly on congested sections. It also lessens the number of stops of long, heavy freight trains, and the roads which have tried it believe that the saving from the use of track tanks is greater in freight traffic than it is in passenger traffic. With the improvement in design, equipment and size of track tanks the cost has, of course, increased considerably. A double track installation

on the Baltimore & Ohio 16 or 17 years ago cost around $10,000. Now a modern plant will cost $15,000 to $30,000, exclusive of grading and track work, depending on the width and length of troughs and the methods used for filling and for heating. The total cost is greater than this by the amount spent on grading, drainage, ballasting and track work, which is different for each job. The maintenance, we understand, will probably average about 8 per cent. of the cost. Track at troughs costs about twice as much for maintenance as elsewhere. The cost of operation varies considerably. The labor cost is about double that at a station of equal importance without track tanks; the fuel for pumping will probably be at least double because of the waste of water, and of the heating. The heating cost is a great variable, not only as between stations, depending on local conditions, but for the same station for different years. As regards local conditions, a station supplied from a river will need more heat than where the water comes from a well; the regularity of train movements also has considerable effect, frequent scooping being a great help in cold weather.

The Lake Shore at present has nine track tank stations between Chicago and Buffalo. There are some pretty long stretches between some stations, and we understand these will be broken up, the ultimate plan being to have track tanks or regular stops at intervals of about 20 miles. This is to meet the requirements of freight service, passenger trains not needing intervals shorter than 40 miles.

KEEPING PERMANENT WAY MAINTENANCE DOWN.

It was in 1900 that the quantity of traffic carried by our great transportation systems began to advance in ever increasing strides, so that in the years 1901, 1902 and 1903, the amount was so great as to well nigh swamp even the best managed and best equipped railroads, and cause those years to be ever after remembered as strenuous ones. This increase was slightly checked in the latter part of 1903, but the struggle to make the improvements and additions surpass or "get ahead of" the business had already begun in 1900, and the work was advancing with ever increasing vigor. Money was literally poured in for additional facilities, and the increasing tonnage together with the increasing rapidity of the service, the units which hammer down the permanent way, caused the expenditure of heavy sums for the maintenance and improvement of the roadbeds and tracks, which were the foundations for this mighty business. These heavy expenditures were kept up with scarcely a halt to the very threshold of the panic of 1907, when they were brought to an end more suddenly than has been known before in the memory of the present railroad officers, although the signs were apparent for some time in advance.

We have been examining into the record of maintenance of way and structures expenses given in the annual reports of some roads, and have reduced those of one of them for several years back to the cost per mile of all tracks, and the cost per train mile, both passenger and freight, in order to facilitate comparison, and present the results in the accompanying tables:

TABLE I.—*Maintenance of Way and Structures Expenses.*

Year.	Per mile, all tracks included.	Per train mile, pass. & frt., cts.
1895	$946	.....
1896	875	.....
1897	933	.....
1898	1,165	.....
1899	1,220	19.451
1900	1,298	21.571
1901	1,247	20.616
1902	1,363	21.906
1903	1,363	21.343
1904	1,218	19.730
1905	1,421	23.164
1906	1,610	25.506

By examining Table I, it will be seen that the expenditures from 1895 to 1897 were moderate, at $875 to $946 per mile. but that with 1898 they began to increase, and in 1906 reached the large expenditure of $1,610 per mile of all tracks, including sidings and yard tracks. There is evidence of a slight check in 1904, but it is well known that some companies did not even check their new construction work in that year. It is to be noted that the expenditure per train mile unit increased as well, indicating that for every train run over the road more money was being spent for an improved roadbed and track. It reached 25½ cents per train mile in 1906.

In Table II, the maintenance expenditures have been separated into their component parts, and in addition to the expenditure per unit of track and of traffic, the percentage which each account bears to the total M. of W. & S. expenses is shown. The main object of the statement is to show how large a proportion of the expenses is on account of labor directly employed by the railroad company. Of course, labor enters into the manufacture of articles which are regarded strictly as materials, but in such a case it is not directly employed by the railroad company. Accounts Nos. 3 and 4, amounting to from 25 to 30 per cent. of the total, are, therefore, to be regarded as strictly material accounts, and are for rails, track appliances and cross ties; the labor for applying them is not charged to the material.

Accounts Nos. 2, 5, 6 and 7 are partly material and partly labor, while No. 1, amounting to from 30 to 40 per cent., is wholly for labor. It is thus probable that from fully 50 to 65 per cent. of the entire M. of W. & S. expenses are on account of labor actually employed by the railroad company. In times of depression, it is quite possible and entirely safe to cut the rail and track appliance allotment, because a large percentage of rail is removed from the tracks, not because it is worn out, but because its surface has become impaired, and trains do not ride quite as smoothly as the administration desires. By referring to the table, it will be observed that from 1896 to 1899 the expenditures to this account varied within narrow limits, $139 to $170 per mile of track, while from 1900 to 1906, both inclusive, with the exception of two years, the expenditures were much larger, $216 to $268 per mile of track.

In the case of ties, it is necessary to carry on the renewals with more regularity, as will be observed, because their replacement is governed by the law of decay, not of traffic units, but even in the case of ties, it is possible to reduce the requirements somewhat by the exercise of close scrutiny. There will also be irregularities in the tabular record due to the necessity from time to time for beginning the renewal of a large number of the ties in tracks which were built a few years before, and are now ready for the first replacements. An interesting feature of the table is the increase in expenditures per mile for account No. 2, bridges, and all kinds of buildings and structures, for the past ten years, due largely to the increase in the size and weight of rolling stock. It has been necessary to replace bridges which were only from ten to twenty years old, to enlarge round houses, turntables and shop buildings, and to improve the coaling stations and freight houses. It has been a transition stage with which the transportation lines have had to contend during the period of greatest expansion of traffic in a short time in their history.

Item No. 1, Section Labor, is noteworthy. Since 1896, or in ten years, the expenditure for keeping the roadbed and tracks in good condition has doubled. From expenses of $300 to $396 per mile of track between 1895 and 1901, the amount jumped to $485 in 1902, $498 in 1903, dropped back to $442 during the slight depression in 1904, rose higher than ever to $573 in 1905, and reached a maximum

TABLE II.—*Maintenance of Way and Structures Expenditures Separated into Their Component Parts.*

Year.	1. Section labor.			2. Bridges and buildings			3. Rails and track appliances			4. Cross ties			5. Miscellaneous labor & material			6. Signals, teleg. & telep.			7. General		
	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.	Pr ct. of total M. of W. exp.	Per mile all tracks.	Per train-mile pass. & frt.
	Pr ct.		Cts.	Pr ct.		Cts.	Pr ct.		Cts.	Pr ct.		Cts.	Pr ct.		Cts.	Pr ct.		Cts.	Pr ct.		Cts.
1895	36.0	$341	....	20.2	$192	....	12.4	$118	....	14.2	$134	....	6.9	$65	....	3.0	$28	....	7.3	$69	....
1896	33.5	294	....	18.6	156	....	15.9	139	....	15.4	135	....	6.8	59	....	2.9	33	....	6.9	59	....
1897	34.4	313	....	16.1	147	....	14.3	130	....	15.1	138	....	7.3	66	....	3.3	30	....	9.5	109	....
1898	27.9	325	....	18.4	215	....	14.6	170	....	11.4	133	....	6.0	70	....	3.5	41	....	18.2	212	....
1899	30.6	373	5.96	30.0	366	5.84	12.2	148	2.36	12.0	146	2.33	6.4	79	1.26	3.5	43	0.68	5.3	65	1.05
1900	28.9	374	6.22	19.6	255	4.23	20.7	268	4.45	14.9	193	3.21	8.0	104	1.72	3.9	51	.84	4.0	53	.89
1901	31.6	396	6.51	21.8	274	4.51	17.9	225	3.69	13.9	175	2.87	6.6	75	1.36	3.5	43	.71	4.7	58	.96
1902	35.7	485	7.79	23.0	312	5.01	13.7	185	2.98	12.4	168	2.70	6.9	100	1.00	3.8	52	.83	4.5	61	.88
1903	36.5	498	7.80	18.2	248	3.89	15.8	216	3.38	13.5	183	2.87	6.5	89	1.40	5.2	71	1.11	4.3	57	.89
1904	36.3	442	7.17	16.5	201	4.25	20.3	248	4.01	12.4	151	2.45	5.4	66	1.07	4.2	50	.81	4.9	50	.97
1905	40.4	573	9.34	17.1	243	3.95	11.5	164	2.67	13.4	190	3.10	8.1	115	1.88	5.0	72	1.16	4.5	64	1.06
1906	39.2	632	9.98	16.1	259	4.09	14.8	236	3.77	11.6	187	2.95	9.0	156	2.30	5.2	83	1.32	4.1	67	1.01

of $632 in 1906. This certainly indicates an excellent condition of permanent way. The cost per train mile points out, too, a steadily increasing quality of roadbed and track. Whereas about six cents were spent for labor in 1899 for each train run one mile, in 1906 almost ten cents were spent on the roadbed and track for each train run one mile.

There is no task so pleasant to the operating officer as that of employing a large number of men to keep his property in fine condition at all times. This has been the characteristic task of the past seven or eight years, but now storm clouds have arisen and it has become necessary to close-reef and sail under almost bare poles on account of a reduction in earnings which has amounted to 20 per cent. and more. No such drop in earnings has taken place since the depression of 1893 and the railroad manager has before him the plain duty of reducing his expenses to an extent that will enable him, so far as possible, to show a profit from operating under the changed conditions. The disbursement during the last decade has been so generous and open-handed that railroad companies in making these reductions have to go back ten years to establish a comparison. The tables we have quoted prove amply that liberal reductions can be made without impairing the efficiency of the property. They show also that the very high cost which has been paid for labor, both by unit of time and by unit of performance, must certainly bear its share of the reduction—were any other evidence needed to prove this than that of the many workmen now without employment.

A DECADE OF BRIDGE DESIGN AND CONSTRUCTION.

The introduction, about a dozen years ago, of modern freight cars of large capacity, and the practice of hauling heavy train loads to reduce the most of operation, led to a rapid increase in the weight of locomotives, which in turn required extensive rebuilding of bridges on the principal railroads of the country. Whenever it was possible to reduce the span by the addition of extra piers, plate girders replaced old pin trusses as well as plate girders designed for light loading. In building new railroads, the plate girder has likewise been favored, so that during the past decade the construction of bridges of this class has been unprecedented. As the span and loading have been increased, new forms of flange sections as well as more effective web splices were designed. The most decided change relates to the extensive adoption of pin bearings and segmental expansion rollers. In several important particulars, theoretic considerations are given more consideration than formerly.

In order to secure greater stiffness as well as strength, riveted truss bridges have been substituted for pin bridges and gradually their span has been increased to about 160 ft. and occasionally to nearly 200 ft. Increasing attention has been paid to the design of details calculated to develop the full strength of the main sections of members. In pin-connected trusses, the widths of eye bars for short spans are now equal to those formerly used for spans two or three times as long. The sizes of pins have been similarly increased, while the reinforcing pin plates are more scientifically designed, not merely to furnish adequate bearing, but to distribute the stresses properly among the shapes composing the members. Secondary stresses are reduced as far as practicable by making the axes of connecting members intersect in a point. Not only are adjustable members in short pin spans more generally avoided in the main trusses, but the lateral systems as well as the portal and sway bracing are built of shapes designed to resist both tension and compression.

There has been a tendency to increase the depth of the floor system and to lengthen the panels, the maximum length for simple trusses now being 37 ft. for a span of 407 ft. The use of end floor beams for short spans is coming into more extensive use, although originally designed for only long span truss bridges. A reaction has set in against the extreme curvature of the upper chord of long span trusses that was in vogue for some years. The relative reduction in depth adds some metal to the chords but secures posts of greater stiffness. At the same time the general appearance of such trusses is improved. A good illustration of this may be seen in the bridges at Port Perry and at Brilliant, Pa., on the Pennsylvania Railroad.

Several railroads are now designing all their bridges for Cooper's E 60 loading. Class E 50 was the highest loading tabulated in the 1906 revised edition of Cooper's Specifications; E 40 in the edition of 1896. The latest specifications designate E 40 as the minimum loading for railroad bridges.

An important step in the progress of bridge design was the adoption in 1906 of general specifications for steel railroad bridges by the American Railway Engineering and Maintenance of Way Association. The details of design were under discussion by the committee and before the Association for several years, while the specifications on materials and workmanship were under consideration for sir years. Special studies of the literature and the latest practice regarding some topics were made before the adoption of the corresponding paragraphs of the specfications. The adoption of these recommended standard specifications by the railroads will help to secure still further improvement in details and in the general character of bridge structures.

Last summer the Association, through its Committee on Iron and Steel Structures, began to determine experimentally the actual stresses in bridge members when trains cross the structures at different speeds, in order to find the effect of impact or the dynamic increment to be added to the computed live load stresses. During the previous year the Association secured the co-operation of many railroad companies in defraying the necessary expenses, and it is expected that these tests will be continued during the coming summer. The allowances made for impact in specifications prepared by various prominent engineers differ widely from each other, and it is gratifying to look forward to the early elimination of this element of uncertainty from the design of railroad bridges. The need for such tests has been advocated for a long time by competent critics. A beginning was made in a small way a number of years ago, and more recently over two thousand records were obtained on the Baltimore & Ohio Railroad, but, unfortunately, they were destroyed in the Baltimore fire before they could be thoroughly studied.

During the decade, 1888-1898, a large amount of solid floor construction of various designs was introduced in connection with the abolition of grade crossings in several large cities, notably in Chicago, while a few railroads adopted it as the standard for other bridges also. Observation of these structures has shown that in most cases the solid floors as designed were too shallow either for stiffness or for durability, so that the more recent designs employ greater depths and simpler details, affording more convenient inspection of the steel work. The substitution of creosoted timber and water-proofing in place of steel plates has been made to reduce to a minimum the metal subject to corrosion and thereby to diminish the cost of maintenance.

A more radical change in the design of solid floors consists in placing reinforced concrete slabs on the metal floor system in order to support the ordinary railroad track with ballast. This construction has been adopted experimentally with a view to more extensive use if experience proves it to be satisfactory. Some bridge engineers are of the opinion that ballasted floors should finally replace all open floors in railroad bridges. There is an impression that the use of ballasted floors will materially reduce the effect of impact for live loads and the results of experiments on this subject will be awaited with keen interest.

One of the most characteristic features in bridge development during the past decade is the extensive adoption of the lift bridge both for railroad and for highway traffic. Only three bridges of the type known as the Scherzer rolling lift bridge were in use before 1898, all of these being located in Chicago, while since that time more than thirty of the same type have been built in various parts of the country, nearly half of them carrying railroad traffic. During this period the greatest span has been increased from 127 to 275 ft. A modification of this type known as the Cowing lift bridge was introduced a few years ago, the first one being built at Cleveland.

Since 1901, more than a score of trunnion bascule bridges have been built, including some of the Page and of the Strauss forms, but most of them were designed by the bridge departments of municipalities, especially Milwaukee and Chicago. The spans range from about 33 ft. to 205 ft. 7 in.

The hinged lift bridge has been revived to some extent with different counterweight arrangements than those used in ancient times. Some improvements have likewise been made to the direct lift bridges, a type which, with one exception, is used only for very short spans crossing canals. In these modern forms both the trusses and floor are lifted vertically, air-tight pontoons replacing the counterweights in some cases. The most novel form of movable bridge is the aerial ferry bridge crossing tne ship canal at Duluth, completed in 1905. The movable car is supported by a track on the lower chord of a truss having a clearance of 135 ft. above the ordinary stage of the water.

The advances made in the design of swing bridges have been mainly those required to keep pace with the increase in live loads and in improving the mechanical details so as to reduce the cost of operation and maintenance. Only nine swing spans over 400 ft. long were built in the last decade, the maximum span being raised exactly one foot over that reached before. More cantilever bridges with spans exceeding 400 ft. were erected than in the decade immediately preceding—in fact, almost as many as were built in the two previous decades, a period extending back to the introduction of the cantilever in this country, in 1877. Counting short as well as long spans, ten cantilever bridges were erected between 1877 and 1897, 25 between 1888 and 1897, and 19 between 1898 and 1907, exclusive of the Blackwell's Island bridge, not yet completed.

The Blackwell's Island bridge has a span of 1,182 ft., which is 370 ft. longer than the next in order, the Monongahela river bridge at Pittsburgh. This 182-ft. span was in turn to be exceeded 618 ft. by that of the Quebec bridge, nearly one-half of which had been erected when it collapsed August 29, 1907. The design of the Quebec bridge has covered nearly the entire decade just closed. Its collapse has been properly characterized as the greatest engineering disaster of the period.

The engineering profession awaited anxiously the publication of the complete report of the Investigating Commission of the Canadian government, the findings of which are printed this week in another column. That the profession will take the lessons of this disaster to heart is indicated in many ways. Hardly a week has passed without the publication of articles in the technical periodicals on the design of compression members, including that of lacing, and on full-size tests, some of which were made many years ago and ought to have been published then for the benefit of bridge design. Prominent engineers representing the interests involved in both the design and manufacture of bridges, are trying to induce the government to build a testing machine of far greater capacity than any now in use, in order to extend materially the investigation of full-sized compression members. It may not be amiss in this connection to call attention to the tendency to cut down the weights of details of other than great cantilever bridges which, like lacing, have not been subjected heretofore to a satisfactory theoretic treatment. The careful analysis of the weights of details of bridges of all classes would do much to correct mistaken ideas of economy where they exist.

Only three suspension bridges with spans over 600 ft. long have been erected in this country in the last ten years. The Williamsburg bridge belongs to this decade. While its span is only seven inches longer than that of the Brooklyn bridge, completed 21 years before, it was designed for a much greater traffic.

Although the Chestnut street cast iron bridge in Philadelphia was completed 42 years ago, and the famous Eads bridge at St. Louis was begun a year later, one-half of all the metallic arch bridges without hinges have been built within the last decade. The number of such structures is comparatively small, American engineers preferring the use of two or three hinges. The first bridge with two-hinged arches in this country is only about 20 years old; hence it is not surprising that at least one-half of the bridges of this type were built during the past 10 years, the span being increased 290 ft. over that reached in 1897. The progress in the design of this class of structures is indicated by the projected four-track bridge for the New York Connecting Railroad over the East river at Hell Gate and Wards' Island, the span being 977½ ft. between centers of end pins.

About one-third of the existing three-hinged arch bridges were built during the last decade, while 75 per cent. of the balance belong to the previous one. Only one bridge of this type has been built with a larger span than that reached as early as 1889, the difference being 84 ft. Undoubtedly the number of metallic arch bridges is smaller than it would have been if concrete construction had not assumed such large proportions. Nearly 30 per cent. of those with three hinges are used for railroad service.

The most characteristic feature of bridge construction in the period under consideration is the enormous development in the use of both plain and reinforced concrete for arches with spans ranging from those of small culverts to 233 ft. This length is the clear span of the main arch of the Walnut Lane bridge in Fairmount Park, Philadelphia, which is approaching completion, and is the largest concrete arch in the world. The problem of the erection of an arch of such magnitude required as careful study by the designing engineer as the proportioning of the structure itself. The method of erection was made the subject of definite specifications, as no contractor had sufficient experience to enable him to build the structure without the advice and direction of a competent engineer. In this case two narrow arches are built near together and the intervening space is bridged over by the floor system.

Another example worthy of especial mention is the Connecticut avenue bridge in Washington, D. C. The outside blocks were cast separately and hoisted into position, while the remaining concrete was deposited in place in the usual way. By using yellow sand in some parts of the exposed surface and bluish crushed stone in place of sand in other parts, two tints are shown according to a definite color scheme instead of the ordinary single color of concrete.

A view of a train crossing a concrete arch viaduct which carries it out of sight of land, has recently been published in the *Railroad Gazette*. This novel structure is two miles long and consists of a series of reinforced concrete arches of 50-ft. in span. It is known as the Long Key viaduct on the Key West extension of the Florida East Coast. As several other viaducts more than a mile long, besides numerous shorter ones on this railroad, are to be built, some idea may be gained of the part which concrete, either with or without reinforcement, plays at present in the development of bridge construction. When the number of concrete bridges now in use is considered, it seems surprising that the first one in this country was designed as recently as 1895 and built in 1896. Study of this problem by a large group of engineers has produced many changes in form and arrangement, effecting the arch ring, spandrel walls, spandrel arches, columns, floor beams and slabs, and reinforcement and the surface treatment of the concrete. In first-class practice, the elastic theory is applied in the design of the arches.

While the extensive development of concrete bridges has been in progress, a considerable number of stone arch bridges and viaducts have been built, notably in rebuilding the Pennsylvania Railroad, in replacing many short metal structures, and in eliminating grade crossings. Some of these bridges are of unusual magnitude, like those crossing the Susquehanna river at Rockville and Shock's Mills. The bridge at Hartford, Conn., is a corresponding example of a large highway structure. In the design of statically indeterminate structures, it is now recognized that special means should be used to complete the erection in such a manner as to make the actual conditions agree closely with those assumed in making the design. Excellent examples of this are given by the means adopted to close the great arches of the Niagara and Clifton bridge; by the erection of the floor system and stiffening trusses of the Williamsburg suspension bridge, and by the manner in which the arch rings of the Walnut Lane bridge were completed by filling in the narrow keys between the segments of the concrete ring previously placed.

In reply to charges made by Social-Democratic members of the Diet of the German Empire that accidents are caused by too long hours of service, Dr. Schulz, President of the Railroad Bureau, said that the accident statistics showed that much the larger number of accidents occurred, not in the later hours of the employees' days' service, as would be the case if due to over-fatigue, but in the earlier hours, when the men are fresh.

The American Railway Engineering and Maintenance of Way Association differs from kindred railroad associations in one important respect, in that its active membership includes a good many men who are not, and never have been, connected with railroads. These men form some of the most valued members of the committees. To get the best results from committee work there must be full meetings and all the members must work. But every committee meeting means a railroad trip, and some incidental expense, at least, to the members attending. The railroad men having passes are, ordinarily, at only a nominal expense for such a meeting unless the session is prolonged. But for the member who cannot have a pass the railroad fare may be a considerable item of expense, which he probably must pay himself. In most instances such members will feel that they cannot afford to attend many committee meetings, perhaps not any, if they intend going to the convention. Committee work naturally suffers under these circumstances. Just how the situation can best be helped is a matter for some thought, and it needs to be thought about, for the valuable work this association is doing for the railroads should be freed from such hindrances as much as possible. As a matter of fact, a good many of the railroad men who do committee work cannot afford the expense incident to this work. It is enough if they give of their time and energy. Some means should be provided for reimbursing members of committees for any personal outlay incident to their work. The association cannot do this; it hasn't the means. As the chief beneficiaries of this work the railroads might well feel that they can afford to subscribe to a special fund to be used by the association for this purpose. In thus aiding the activities of this organization they are materially furthering their own interests.

NEW PUBLICATIONS.

Electric Railways. Vol. II. By Sidney W. Ashe, B.S., E.E.. New York: D. Van Nostrand Co. 282 pp.; 5¼ x 7½ in.; 145 illustrations. Cloth. Price, $2.00.

This volume, while forming the second of a series that the author has in preparation, is complete in itself, and deals, in the early chapters, with the engineering preliminaries that must be taken into consideration in locating and building electric railways, closing with a discussion of direct-current sub-station work. The first volume of the series, which was issued some time ago, dealt with the subject of rolling stock.

The first consideration in the location of an electric railway should be, will it pay? And in the discussion of the preliminary investigations that should be made, the author outlines the methods to be pursued. These include a study of the character and amount of population, the probable number of passengers the territory will contribute, the type of cars and motors, the speed and load diagrams, and many other items of first cost and operation that will have an influence in the solution of the problem. The empirical basis for the work is given in a long list of electric railways, located all over the United States from Maine to California and from the Lakes to the Gulf. There are 46 centers of propulsion thus selected, and from the summary prepared, it appears that the railways carry, annually, about 68 passengers per inhabitant. Having determined the present population, the next step is to consider future growth, and instances are cited to show the method of plotting the curves.

When the probable traffic has been estimated, the next step is to determine the electrical features and the type of rolling stock to be used, and various methods for accomplishing this are explained and discussed, including the speed, acceleration and power curves of various cars and motors, followed by the methods of arranging for schedules and the load diagrams of the power plant.

This part of the work occupies the first four chapters. In the fifth, the power house location takes first place, and in this is included that of the sub-stations. In this the capacity is taken up, as well as the cost. Examples are given of the range of these costs per kilowatt, which shows such great variance that it is evident that no calculations for a specific case can be made on general principles or from average data, but each one must be worked out from its own local conditions.

In this treatment of the subject no attempt is made to discuss the electrical features or the details of the apparatus used. The work is confined to the arrangement of the buildings, the purposes to be served by the station, and the only reference to the construction of the apparatus occurs in connection with this arrangement. For example, in considering the local storage battery, the voltage and amperage that are giving good results, the author states the methods of charging, the usual arrangement and the switch connections. In chapters VII. and VIII. the rotary converter and transformer and their methods of operation are described, but this is in connection with their functions rather than in the details of their construction.

In chapter IX. specifications are given for insulating oils, in which greater emphasis is put upon purity than on any other quality. In fact, they are based upon the proposition that, "all oils whether mineral, vegetable or animal, when pure, are good insulators," and the wide range found in the insulating qualities "seems to be due, not to the chemical composition of the oil but to its purity." The book closes with a brief description of the auxiliary sub-station apparatus and the methods of its operation.

Cram's Standard American Railway System Atlas, 1908. World edition, with detailed Maps of Foreign Countries. 642 pp.; 14 x 18½ in. Cloth; $12.50. George F. Cram, 130 Fulton St., New York, and 55 Market St., Chicago.

Cram's atlas has several excellent features; it shows interurban trolley lines, indicates important towns with a red circle, prints its railroad lines in colors, so that they may be more readily distinguished, and uses type that is easy to read. We have always found it serviceable and accurate.

CONTRIBUTIONS

Car Wheels.

Philadelphia, March 10, 1908.

To the Editor of the Railroad Gazette:

The work done in the last five years by the Master Car Builders' Association's standing committee on car wheels has resulted in efforts by the makers of cast-iron wheels to improve their product so as to make them serviceable under cars of 100,000 lbs. capacity. There has been, however, so little improvement that it is now time to admit that the passing of the use of cast-iron wheels under high capacity cars is as sure as is the passing of the wooden car affirmed by A. M. Waitt in his recent paper on steel cars.

It has been said that 72 per cent. of the cars built last year were of either steel or steel underframe construction. Probably 50 per cent. of these were of 100,000 lbs. capacity. Investigations have proved that steel wheels under these cars are safe and, because of longer life, cheaper per car-mile than cast-iron wheels. If it is felt necessary or advisable to try something still better than the steel wheel, or as good and cheaper, then let all efforts be bent to this end. But someone must take the lead. A number of years ago a standing committee of the Master Car Builders' Association was appointed to design steel underframes and steel cars. This committee went on from year to year making progress reports, but no definite progress. The problem was finally taken up by a manufacturer, who put into it all the energy and enthusiasm he had. What he did not know he hired. As a result, there are, to-day, probably $500,000,000 worth of these cars in use in this country. On many roads they mean the difference between a deficit and a dividend; and in all cases, increased profits. The car wheel will be developed in the same way. In the meantime let us all put our energy into going ahead on the lines already proved best, instead of criticising and wondering if this or that thing could not be better done in some other way. If we put off doing anything at all as long as any one has a theory that other ways may be better, we shall never get anywhere.

CHAS. T. SCHOEN.

What Are We Going to Do About Accidents?

To the Editor of the Railroad Gazette:

The correspondence on "What are we going to do about accidents" in your issue of February 28, does not, I think, fix any large measure of responsibility for accidents on railroad labor organizations. The inference to be drawn from "General Manager's" letter dated Feb. 15th, is that on the road with which he is connected discipline is maintained and that just decisions made by Superintendents are not reversed at the behest of the "Brotherhoods."

The other "General Manager" who writes under date of Feb. 16th seems to me to place most of the responsibility on those officials who either kept incapable Superintendents in place or failed to support capable officers in the proper disciplining of their subordinates. In the final paragraph of this letter, "General Manager" sets forth plainly how good discipline may be obtained and maintained.

My knowledge of military affairs is superficial and I may be mistaken in thinking the likeness between an army and a railroad equally so, but even in the army is there no method of appealing from disciplinary decisions? If the sentry accused of falling asleep at post protests his innocence, can the sergeant forthwith put him in clink for 30 days? And if the group of corporals believed their lieutenant had set them tasks not provided for in the articles of war, or whatever the form of their contract with the state may be named, have they no appeal? And if they have and use it, does the discipline of the army suffer thereby? Do you think the grant of arbitrary power to the Superintendent will bring about order and good service from subordinates?

On one of the best managed roads in this section, the right of appeal was recognized. In minor cases the appeal from the Superintendent's decision was to the General Superintendent only, but should the employee's position be in jeopardy he might have his case reviewed by the General Manager. This rule involved no humiliation to the Superintendent, its operation occasioned no retaliation by him on the subordinate. Appeals were frequent, reversals rare and discipline well maintained. The possibility of appeal from a Superintendent's decision and practical certainty that, if well founded, it will be enforced should and will serve to make that official more careful in his investigations and more secure in his authority.

It is not unusual for railroad officials to disregard the violation of rules when there is apparently no danger to result therefrom and when some immediate advantage is to be gained. A train on which I was traveling recently was stopped between stations by the bursting of an air hose. One of the principal operating officers of the road who was in his car at the end of the train came out and looked on while conductor and brakemen replaced the hose. He apparently did not note the failure of the flagman to comply with the rule.

Do you not think the laxity of discipline, and consequent accidents, may arise from an indisposition on the part of officials always and indiscriminately to enforce train and other rules, and enforce them whether the offender be a Brotherhood man or not? Appeals, even though backed by "Brotherhoods," don't mean reversals; one "General Manager" gives testimony to that, and the other "General Manager" shows us how to build up discipline, enforce rules and minimize accidents. To his general recommendations, I would add one more: appoint one or more experienced railroad men as inspectors (not detectives) reporting to the chief executive officer of the road direct. Require the inspector to note not only how the men obey, or disobey, the rules, but how officials enforce the rules.

VICE-PRESIDENT.

Railroad Track Tanks.

BY H. H. ROSS,
Assistant Engineer, Lake Shore & Michigan Southern.

Track tanks have been used since 1857, when they were installed on the London & North Western Railway of England. In the United States, the New York Central used track tanks in 1870. The practice in England is to use troughs of sheet steel, or iron; in a few cases cast iron is used, and one road—the Great Northern of England—uses troughs of creosoted wood fastened by cast iron brackets to the ties. The English trough is usually supported upon wooden stringers fastened to the ties, the top edge of the trough being bent over and bolted to the top of these stringers. In the United States, troughs are of sheet steel and are supported directly upon the ties, although at one time the Chicago, Milwaukee & St. Paul had a track tank between Chicago and Milwaukee made up of cast iron sections, each section being 6 ft. long.

The relative elevation of the top of rail and top of trough is governed by circumstances. In England the trough is about 3 in. higher than the rail and at the ends the rail is raised 6 in., this change in grade being made very rapidly, usually in 180 ft. In the United States the top of rail and top of trough are about the same height. The main advantage of English practice is that the scoop does not have to work through such extreme limits, and there is no necessity for inclines at the ends of the trough, but this would not be practicable on our railroads, as the bottoms of hopper cars, the brake rigging and other apparatus do not have as great clearance as in England and the troughs would be injured. American practice is to allow nothing between the rails which projects above the rails. It is entirely possible to maintain track tanks on curves—English roads not hesitating to place them thus, and there are several in this country—but it is not advisable to do this unless absolutely necessary, as much better results are secured on tangents.

Fig. 1—Passenger Train on the Lake Shore & Michigan Southern Taking Water.

Track tanks must be located where the supply of water is abundant as well as of good quality, as, under the best conditions we can hope to obtain, at least 15 or 20 per cent. of the water put into them is wasted by being forced out over the sides and ends by the engine scoops; and if engines scoop at too slow or too great speed, or if the scoops are not kept adjusted, but are allowed to drag on the bottom of the trough, a greater percentage is wasted, probably averaging 50 per cent. for all engines scooping. This difference in adjustment makes more difference in scooping than one would imagine. An engine with scoop properly adjusted will not throw the water badly even at high speed, whereas one too low will throw water all over the right-of-way. Another curious feature is that an engine seems to scoop as much when the water in the trough is an inch or so low as when the trough is full, the reason probably being that the scoop piles up the water ahead of it, or else the force of the water pulls the scoop down deeper. The photograph, Fig. 1, shows about the average amount of water thrown out by the scoop of a passenger engine running 40 or 50 m.p.h.; this amounts to 15 or 20 per cent. of the total taken out of the trough.

Prof. I. P. Church, of Cornell University, made a mathematical investigation of water scoops, and later our road made some practical tests which checked up almost exactly with Prof. Church's formula, viz., that 22 m.p.h. is the minimum speed for taking water and at 25 m.p.h. water is scooped satisfactorily, although more water is forced into the tender at higher speeds, 40 to 50 m.p.h. working about the best; speeds exceeding this are apt to spill the water badly unless the scoop is very carefully adjusted. The grades approaching track tanks must therefore be such that all trains which are to take water can easily attain a speed of 25 m.p.h., and for this reason track tanks should be away from stations, yards, railroad crossings, drawbridges, etc.

The results of the latest Lake Shore tests are shown graphically in Fig. 2. Curve 1 of this figure shows the amount of water theoretically possible to take; that is, the depth of water above the scoop, multiplied by the width of the scoop, multiplied by the distance the scoop is in the water. Curve 2 shows the actual amount of water taken out of the trough by measurement before and after scooping. No. 3 shows the amount actually put into the engine tank. No. 4 shows the depth of water above the tip of the scoop for each of the tests, which explains the irregularities of the curves. No. 5 shows the amount of water taken up by the scoop in percentage of the theoretical amount. No. 6 shows the amount of water taken up by the scoop in percentage of the amount actually taken out of the trough. No. 7 shows the gallons of water delivered per inch of dip of scoop.

Of the above diagrams, No. 6 is the most interesting as it shows that the amount of water actually wasted is about 15 per cent. for a scoop in adjustment and running at a speed of 40 to 45 m.p.h. It is evident from this diagram that speeds below 25 and above 60 m.p.h. waste a good deal of water. This is more important to the maintenance of way department than to the motive power depart-

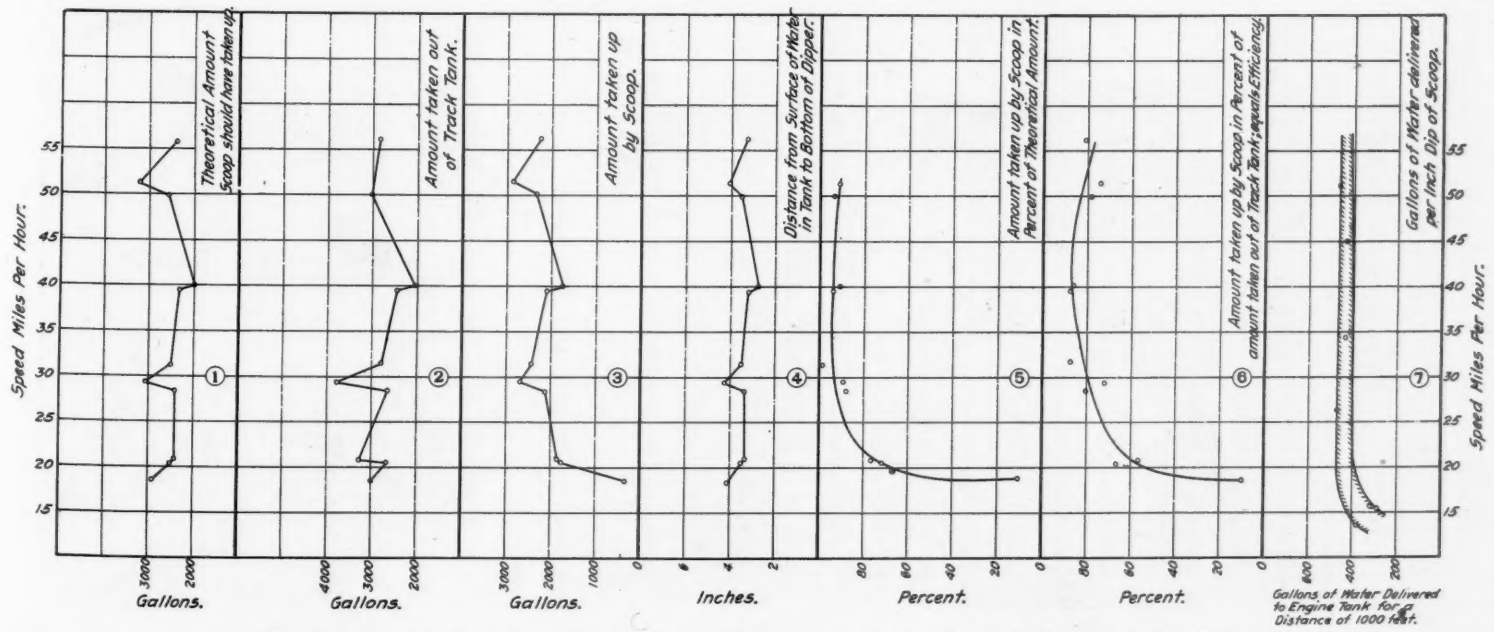

Speed Miles Per Hour.
Theoretical Amount Scoop should have taken up.
Amount taken out of Track Tank.
Amount taken up by Scoop.
Distance from Surface of Water in Tank to Bottom of Dipper.
Amount taken up by Scoop in Percent of Theoretical Amount.
Amount taken up by Scoop in Percent of amount taken out of Track Tank; equals Efficiency.
Gallons of Water delivered per inch Dip of Scoop.
Gallons.
Gallons.
Gallons.
Inches.
Percent.
Percent.
Gallons of Water Delivered to Engine Tank for a Distance of 1000 feet.

Fig. 2—Graphic Results of Water Scoop Tests on the Lake Shore & Michigan Southern.

ment, as is shown by curve No. 7, from which it is evident that an engine will get nearly as much water at 25 m.p.h. as it will at 50 m.p.h. All of this reduced to dollars and cents means that if trains are run at proper speeds for scooping, the bills for water will be 10 to 20 per cent. less than if they try to scoop at speeds below 25 or above 60 m.p.h. Fig. 3 shows the outlines of the scoops used in these tests.

Next to the problem of water supply, that of drainage is most important. The large amount of water wasted keeps the ground under the troughs continually soaked. Therefore, unless the subgrade for a considerable depth is composed of material that will drain itself quickly and thoroughly, artificial means to this end must be provided. This has always been one of the hardest obstacles to overcome. The track would ride badly even if it were being continually worked over. At the present time the construction used on the Lake Shore, which is shown in Fig. 4, seems to meet all requirements. The essential points are to carry away quickly, by means of tile laid between tracks, such water as gets into the bank, and to minimize this amount of water by covering the ballast with large flat stones, so placed that the water will run off rapidly. These flat stones answer another purpose also, as, being very heavy, the force of the water cannot dislodge them and they hold the ballast from being washed out from between and under the ties. Since the Lake Shore track tanks have been paved in this way the track over the troughs rides as well as elsewhere.

Ties for track tanks should be heavier than those on ordinary track to allow for the recess in which the trough rests, and should be sawed so that there will be a minimum amount of work to get everything lined up. These ties should be of white oak or some other hard wood, and all ties should be tie plated. The practice on the Lake Shore is to use ties 8 in. x 10 in. by 8½ ft. long. It is very essential to do this part of the work well, as the expense of renewing ties in such a place is very great; therefore any reasonable increase in first cost will soon be offset by the saving on maintenance charges. The track should be thoroughly surfaced and filled in with stone ballast, and the same quality of ballast should be continued for at least a 1,000 ft. beyond the troughs on the trailing end, on account of the large amount of water that will be spilled from the engine tanks for that distance. The photograph of one of the older steam heated troughs (Fig. 5) shows the above features of paving and type of ties, all of these ties being tie plated.

Water for track tanks is usually supplied from elevated tanks,

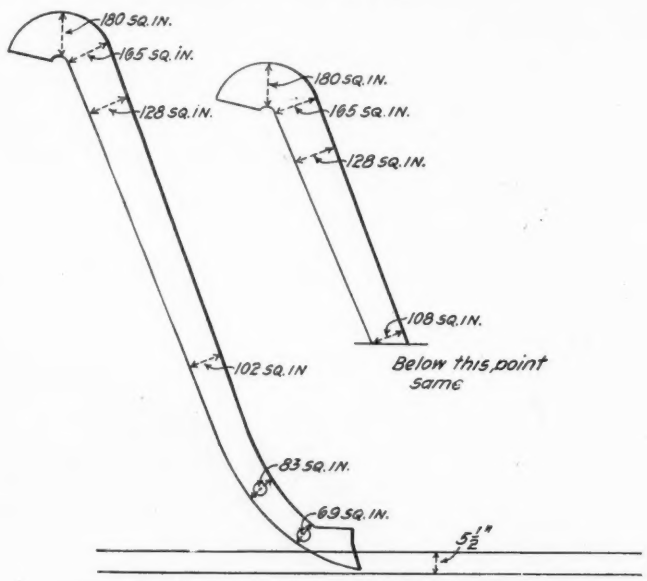
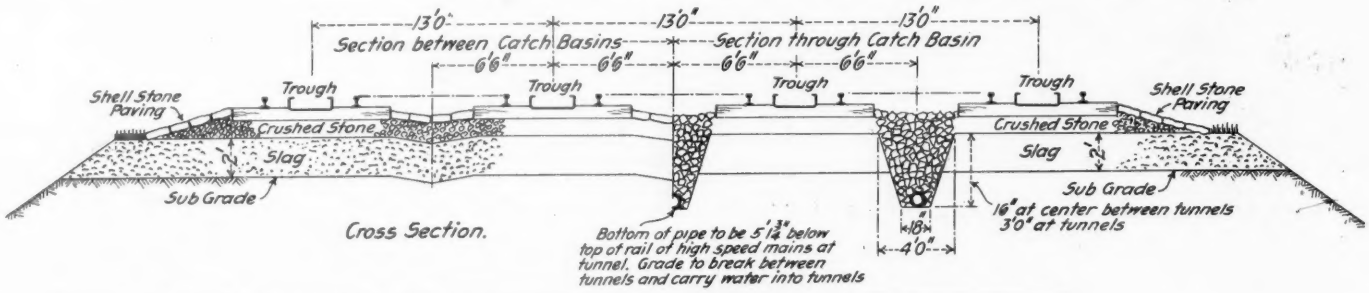


Fig. 3—Outlines of Scoops Used in Tests.



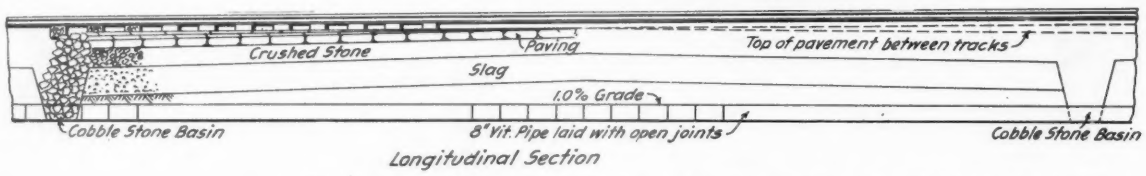


Fig. 4—Details of Track at Troughs; Lake Shore & Michigan Southern.

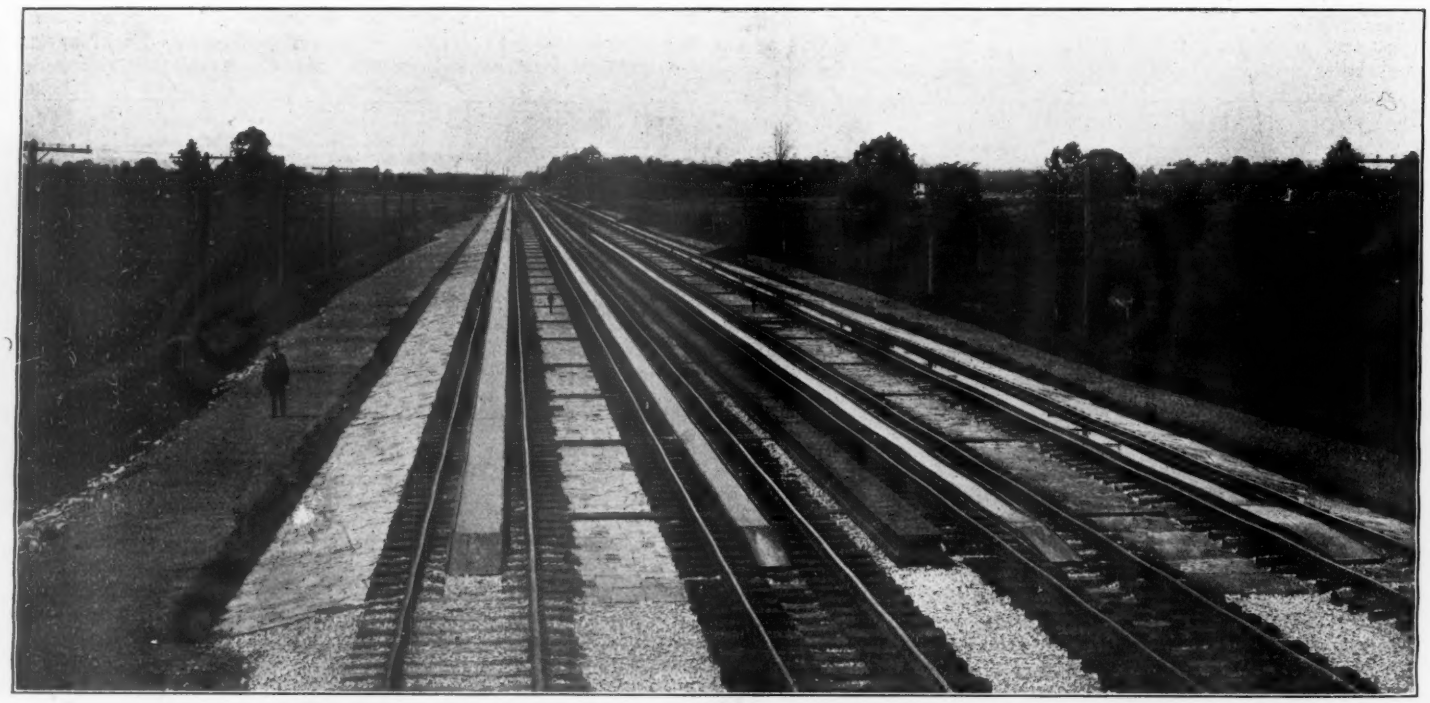


Fig. 5—Track Tanks at Springfield, Pa.; Lake Shore & Michigan Southern.

the size of the pipe supplying the troughs being determined by the minimum time in which it is desired to fill them. On the Lake Shore a 12 in. main is used, reducing this for the different inlets, and it takes 1½ to 2 minutes to refill the newer troughs after a locomotive has scooped. This filling is done automatically, the valves opening as soon as the water in the trough falls below a fixed level. On the older troughs the water is controlled by a man at the pump house, but on account of the personal equation of pump operators it is found much more satisfactory to make this filling automatic. In England a float system is used for keeping the

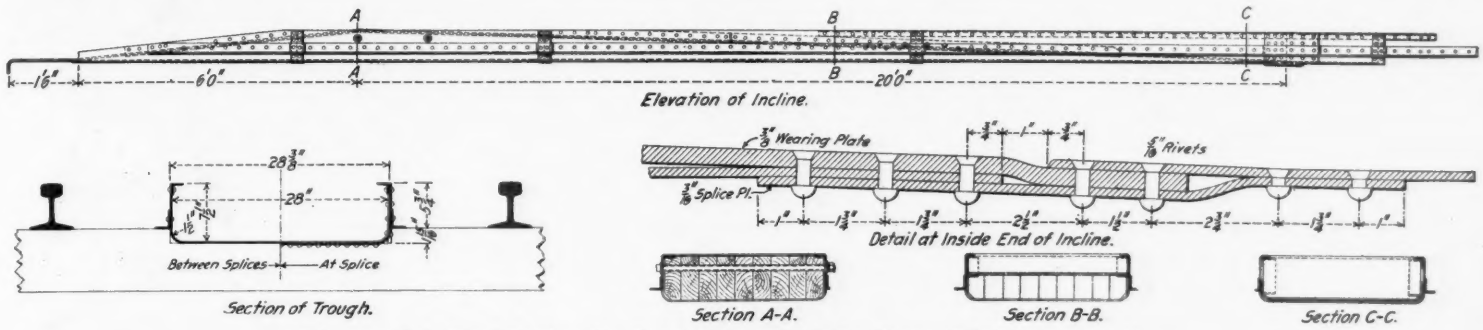
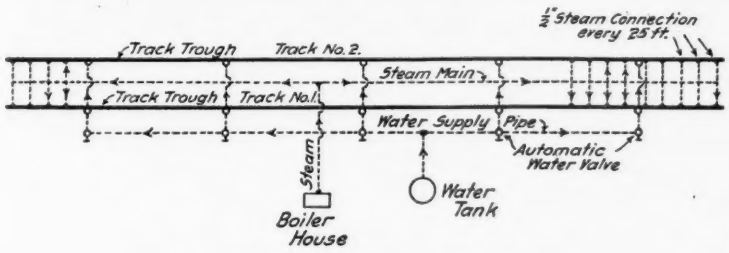


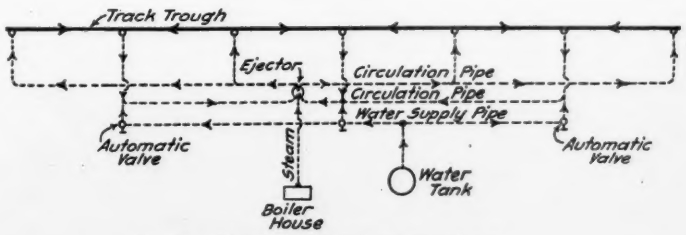
Fig. 6—Details of Incline for Track Troughs; Lake Shore & Michigan Southern.

troughs full and the same object is attained as with our automatic valves.

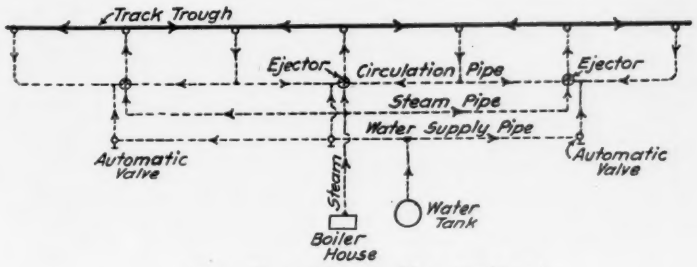
The number of automatic valves per trough varies according to local conditions and class of traffic. The practice on the Lake Shore is to put in three or four valves per trough—three where the inlets are a part of the heating system, and four where a separate heating system is provided. These valves are placed in small pits at the side of the track and are controlled by an equalizing pipe from the trough, connected to a small tank over each valve. In this small tank a float operates a pilot valve that in turn controls the main valve. From the main valve a pipe is run to each trough, being connected to the latter by a short piece of corrugated rubber hose. All of these pipes are run in small cross tunnels under the tracks. By the use of these tunnels and flexible connections all piping is easily got at, and changes due to expansion and contraction, as well as changes in the level of the track, do not cause leaks or broken connections. Another advantage of these cross tunnels is



Steam Heating Method.
Diagram No. 1.



Two Pipe Circulation Method.
Diagram No. 2.



One Pipe Circulation Method.
Diagram No. 3.

Fig. 7—Diagrams of Heating Systems.

deep and 2,000 ft. long. The old style trough was 19 in. wide, 7½ in. deep and 1,400 ft. long. This was all right for passenger trains, but freight trains running 25 or 30 m.p.h. and needing 5,000 to 6,000 gals. of water in the tender required a greater length. The length was then increased to 2,500 ft. and was satisfactory from a freight train standpoint, but the difficulty of keeping the troughs level for this distance was great and it was finally thought best to reduce the length to 2,000 ft. and make the section wider. The main advantage of this wider section is in the greater quantity of water it holds. If a train takes water and for any reason the trough is not immediately refilled, a following train can still get water; furthermore, it is possible to scoop with a double header, the rear engine getting all of the water needed. Other advantages are the possibility of using a wider scoop as larger engines are put in service, and making a stiffer and more rigid construction in the trough itself. The main disadvantages of the wide section are, that with a badly adjusted scoop the waste is greater, and the cost of heating the water in winter is greater on account of the larger surface exposed. This increase in cost of heating is greater than the difference in exposed surfaces would lead one to believe, probably due to the action of the wind.

The question of a satisfactory incline at the ends of the trough to raise the scoop, if for any reason it is not raised before the end is reached, has always been one that has caused the maintenance departments a good deal of trouble and annoyance from the loss of ends and breaking of scoops, and other incidental damage. In England, where the practice of lowering the rails at track tanks is in vogue, there is very little possibility of this part of the trough causing trouble. On the Lake Shore the earliest inclines were quite short, consisting of a steel plate running over the end of the trough and spiked to the ties. These were replaced with an incline 12 ft. long, made of cast-iron and riveted to the bottom of the trough, with a steel plate beyond the end, spiked to the ties. Then for a while no incline at all was used; instead simply a board fastened to the end of the trough, and an auxiliary gate so arranged that if the board end was taken out this gate would swing around and stop the flow of water until the end could be replaced. Beyond the end of the trough a piece of sheet steel was fastened to the ties, and two short pieces of rail in line with the edges of the trough to guard against dragging brake rigging. These board ends have been quite satisfactory, but require a good deal of watching. At the present time the incline shown in Fig. 6 is being used. This incline is built in a very substantial manner, has been deliberately and severely tested, and has withstood all attempts to plow it out; also, on account of the length—20 ft.—it is found that at reasonable speeds scoops are not injured. The construction of this incline is virtually carrying the bottom of the trough up and over the end. A sheet of ⅜-in. steel plate is used and this plate is riveted to the sides of a standard trough section, the space between the plate and bottom being packed with oak fillers. The length of the incline is 20 ft. in the direction of traffic and 6 ft. on the outside to guard against dragging brake-beams, etc., on trains running against the current of traffic. This incline is used at both ends of the trough.

When track tanks are used in cold climates it is, of course, necessary to heat the water in some way to prevent freezing. The practice in England is to station men along the track and keep the troughs open by shoveling out the ice. Also, as their trains run at shorter intervals than ours, their troughs are being filled with warmer water more frequently. If the weather becomes too severe the track tanks are kept out of service. On one English road (the

Lancashire & Yorkshire) steam pipes are carried underneath the trough midway between the stringers on which the trough rests, and the water is kept from freezing by indirect radiation. This is possible with the English troughs, as they are higher than the rail, but it would not be practicable with the construction used in America. In this country there are two methods of keeping the water from freezing: (1) By blowing steam into the water at short intervals, and (2) by circulating the water in the trough by means of a pump and heater, or an ejector. Fig. 7 shows diagrammatically the different methods at present employed, and also a proposed method of circulating. Diagram 1 of this figure shows the usual method of blowing steam into the trough. A steam main is run from the boiler house to a box between tracks. In this box a covered steam pipe runs the full length of the trough and at intervals of 25 or 30 ft. a small pipe runs to the trough. The diagram also shows the automatic valves and water lines.

Figs. 8 and 9 show the details of a four-track steam-heated installation on the Lake Shore at Springfield, Pa., Fig. 5 being a photograph of the same. In a general way this covers all track tanks heated directly by steam. The difference between this and earlier installations is that here the steam pipe is carried above the level of trough and does not become filled with water, whereas the old method was to carry the steam main below the surface, and occasionally it would be split from end to end by freezing. The water connections are controlled by automatic valves and all piping under tracks is placed in concrete tunnels and joined to the trough

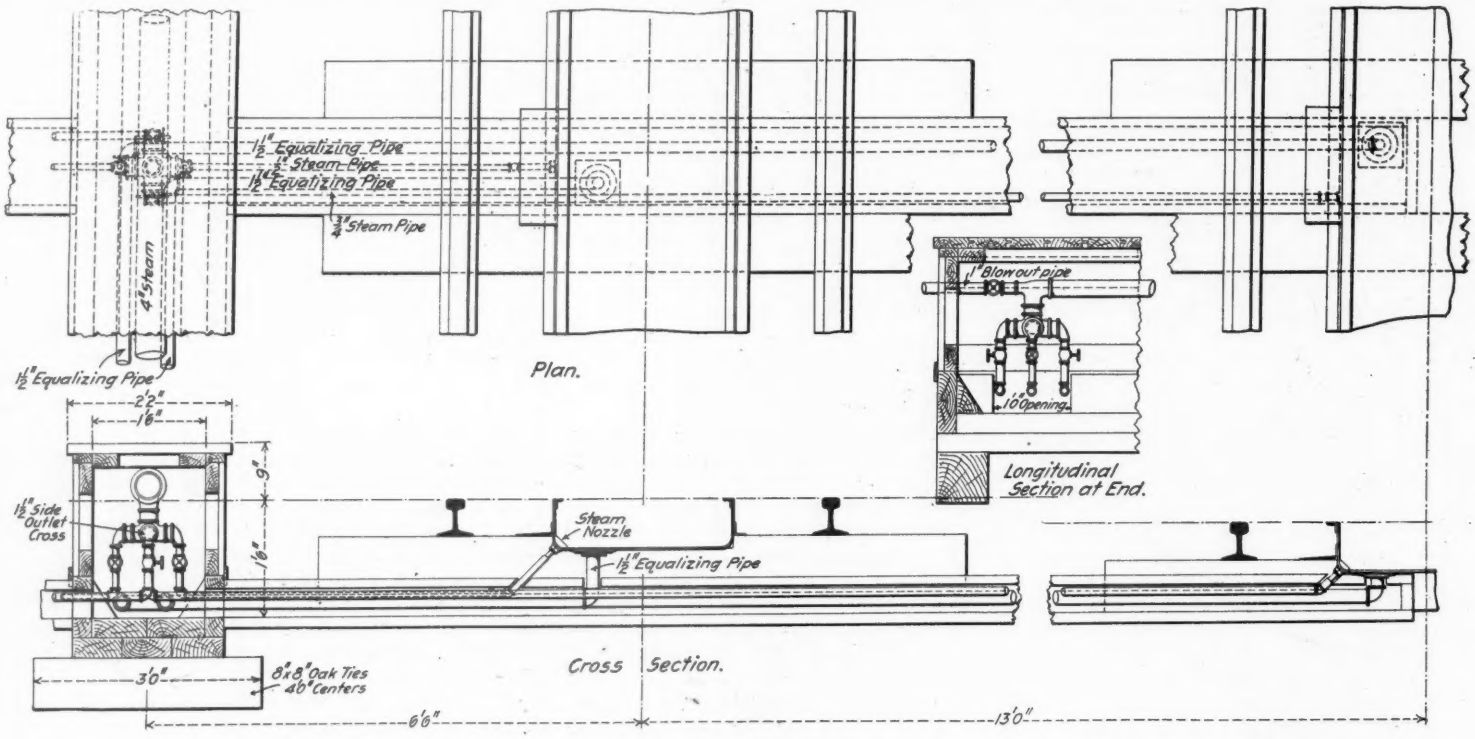
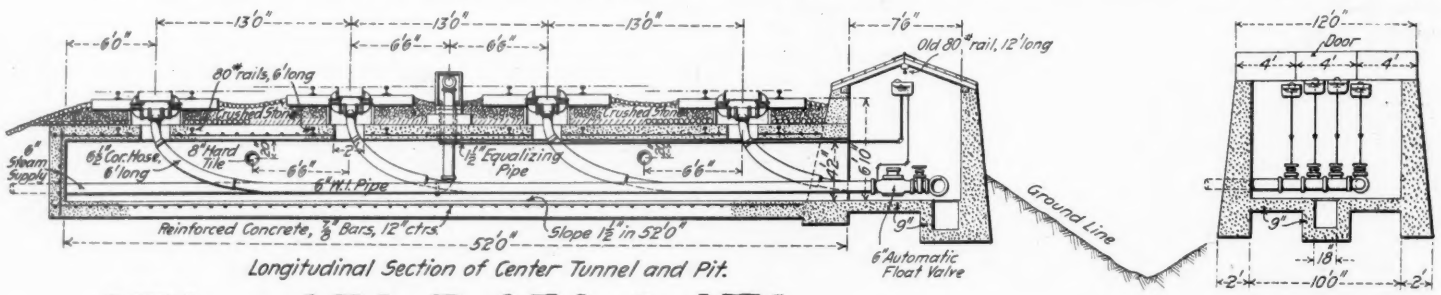


Fig. 8—Details of Typical Direct Steam Heated Installation; Lake Shore & Michigan Southern Track Tanks.



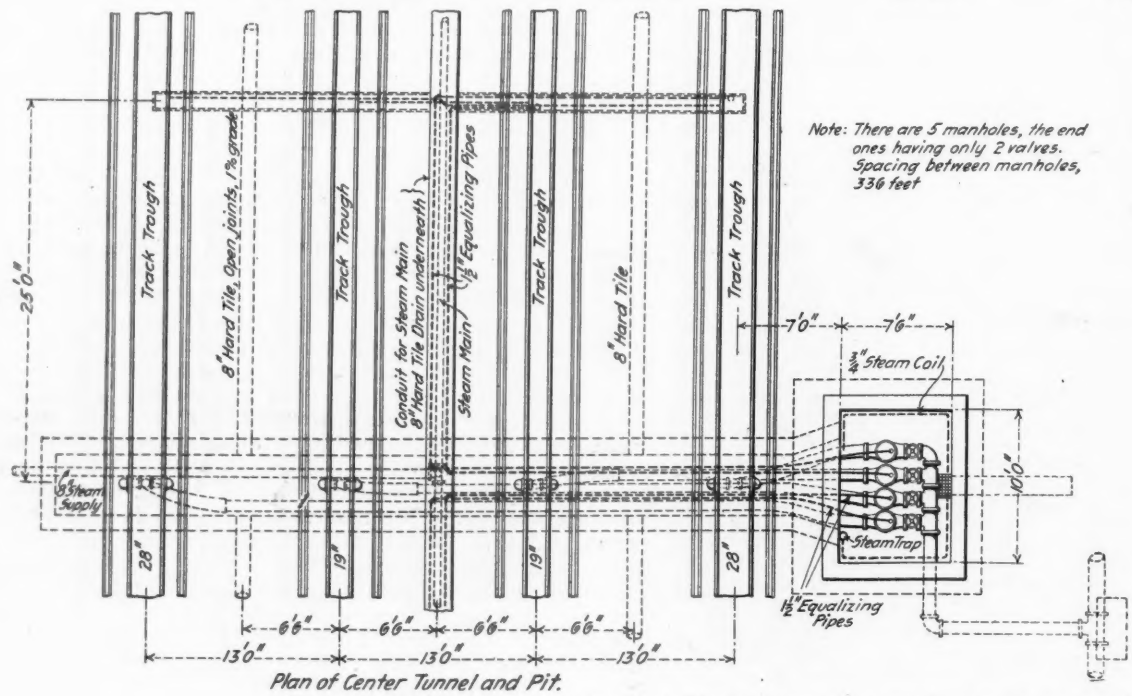


Fig. 9—Further Details of Typical Direct Steam Heated Track Tank Installation.

by flexible connections. The drawings show these features distinctly. In Fig. 5 the valve pits can be seen at the side of the track; also the inclines show plainly in the foreground. It should be explained that the troughs of the two inner tracks in this view are the old, or 19-in., width, and, as may be seen, have been shortened to the present standard length. The outer troughs are the 28-in. width. Markers for night time are placed 150 ft. inside the ends of the troughs. They are switch lights, mounted on a short length of wrought iron pipe having its lower end embedded in concrete, as shown in Fig. 10.

Diagram 2, Fig. 7, shows diagrammatically the double-pipe circulating system used on the Pennsylvania and the Lake Shore.

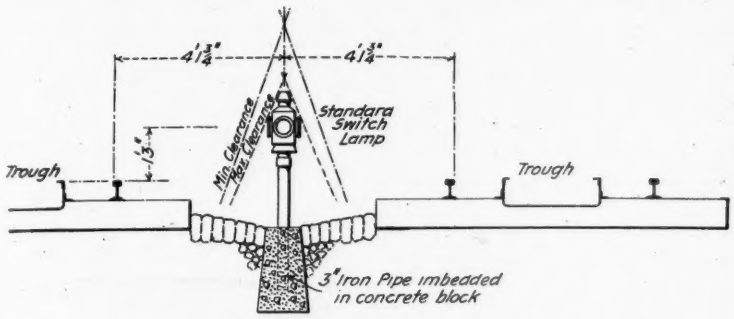


Fig. 10—Standard Marker for Track Troughs.

The water is circulated by an ejector and is heated by the steam while passing through the ejector. The arrows show the direction of flow of water. The water pipes and automatic valves are shown also.

Fig. 11 shows the principal details of this double-pipe system. The top system of piping carries the hot water, and the bottom one brings back the cold water. The advantage of this system over the direct steam is that the track, as far as the maintenance work is concerned, can be handled in the same way as at other points, as there are no steam pipe connections in the way to be easily broken, and there is nothing between the tracks. The piping is all below the surface of the ground and wherever it is connected to the trough a flexible connection is used, so that neither expansion and contraction of trough or piping, nor section men working on the track, interfere with its functions. Trains passing over the direct-steam troughs occasionally have a loose brake rod and this may catch in the steam piping and pull loose all the connections to the trough.

In diagram 3, Fig. 7, is shown a proposed improvement on the double-pipe system. It is proposed to use a single pipe the entire length of the trough for each trough. A steam main will be carried to the next-to-last manhole and ejectors installed as indicated. This will cause a local circulation as shown by the arrows, and if one end of the trough requires more heat it can be easily furnished. The idea is to install all water pipes and the steam pipe in a common conduit underground so that whatever heat is lost by radiation from the steam pipe will be absorbed by

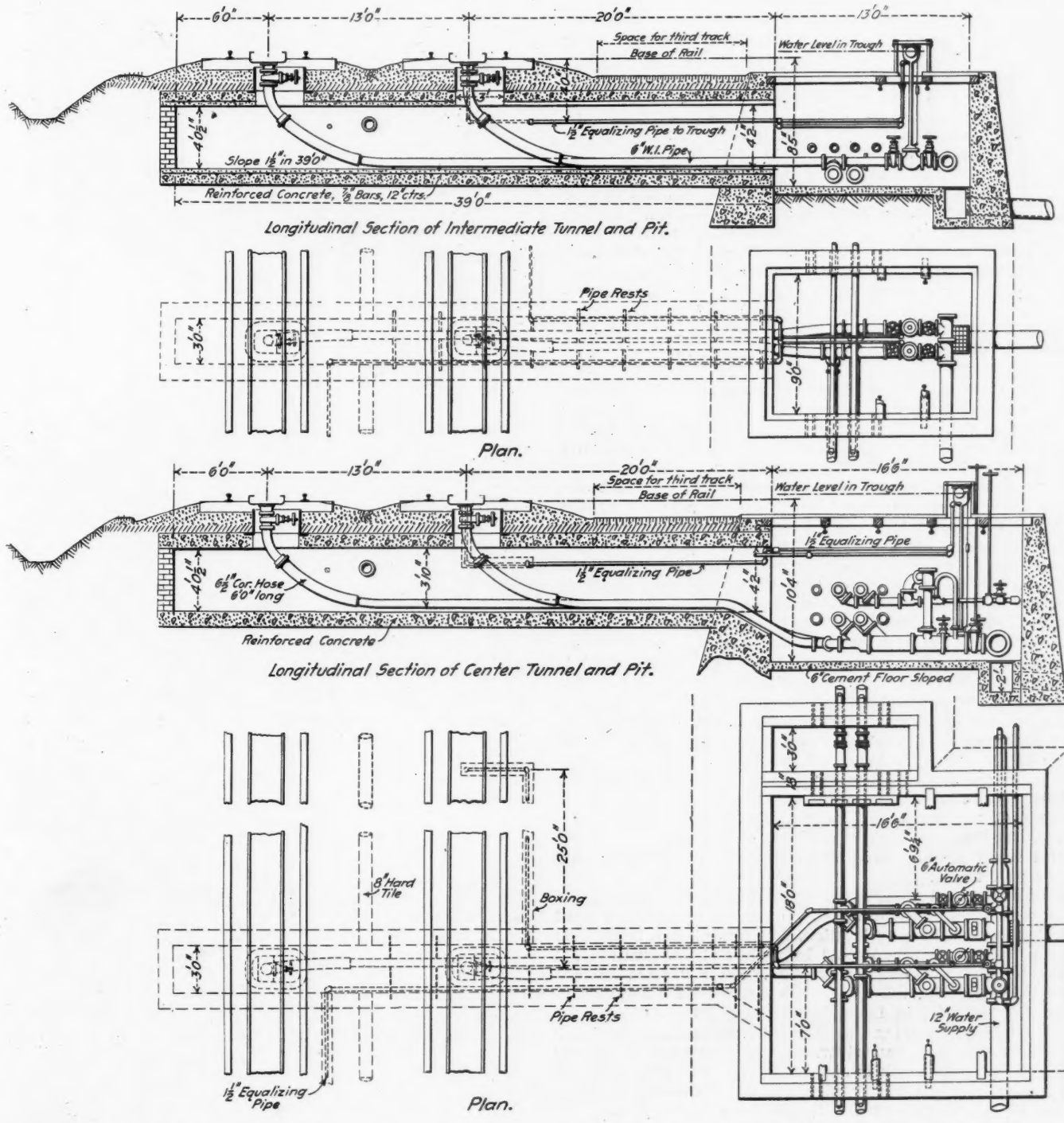


Fig. 11—Details of Water Supply Tunnels and Manholes for Two-Pipe Circulation System to Track Tanks.

the water pipes. The water supply and automatic valves are the same as on the two-pipe system. The advantages of the proposed system over the double-pipe system are: Less first cost and greater flexibility, as the circulation can be localized; heat radiated by the steam pipes is absorbed by water pipes; all pipes insulated and the heat loss minimized.

Earlier articles on one or more features of this subject are given in the following list:

Design of Kiesel balanced scoop, used by the Pennsylvania Railroad, *American Engineering and Railroad Journal*, November, 1896, p. 283; *Railroad Gazette*, Jan. 8, 1897.

Design of L. S. & M. S. scoop, *American Engineering and Railroad Journal*, November, 1900, p. 344; December, 1901, p. 376.

Design of N. Y. C. & H. R. R. R. scoop, *American Engineering and Railroad Journal*, May, 1901, p. 143.

Experiments with scoops, *American Engineering and Railroad Journal*, December, 1901, p. 392; July, 1900, p. 211; November, 1900, p. 344; December, 1901, pp. 376 and 392.

Modern Water Supplies for Locomotives, Proc. American Ry. Master Mechanics' Asso., 1902, p. 287; abstracted in *Railroad Gazette*, July 11, 1902.

Le Genie Civil, Sept. 16, 1899; June 8, 1901.

Railroad Gazette, Dec. 9, 1898.

Bulletin International Railway Congress, September, 1903.

The Sunnyside Yard of the Pennsylvania.

BY F. H. SHAKESPEARE.

The management of the Pennsylvania Railroad, having decided on building the New York extension with its two Hudson river tubes, four East river tubes, underground station at Thirty-third street and Seventh avenue, Manhattan, and the cross-town tunnels under Thirty-second and Thirty-third streets to the river tubes, was confronted with the question of how to provide suitable yard facilities for operating this terminal. The location of a large terminal yard in Manhattan was obviously out of the question, owing to the prohibitive cost of real estate, to say nothing of the improbability of getting a franchise permitting its construction in the heart of the city. Having provided for a yard of very limited capacity in connection with the track facilities at the Manhattan station, the choice of sites for the main yards lay between Long Island and New Jersey, inasmuch as the Manhattan station was to be about midway between the ends of the tunnel. After considering the proposed New York Connecting Railroad in conjunction with the Long Island Railroad (controlled by the Pennsylvania) and the probable first cost of yard construction, the location of the site was decided on in favor of Long Island.

Near the eastern end of the tunnel extension is the Long Island Railroad's passenger terminal station in Long Island City. Near it are the much congested North Shore freight yard and float bridges of the same company. From these terminals the Montauk and Main Line divisions of the Long Island run eastwardly on diverging lines which join again at Jamaica, some 10 miles away. About three miles out on the Main Line division is a junction point where a short line called the North Side division diverges to the northward; close to it is the line of the proposed New York Connecting Railroad which is to make an all-rail connection to the New England states. All three of the above mentioned divisions are at present operated by steam locomotives, but in a few years electrification is to be extended so as to include nearly all the lines within the limits of Greater New York.

The Atlantic avenue, Brooklyn, division of the Long Island is now operated with multiple unit electric trains, and it is intended to use this class of equipment for all suburban traffic both on Long Island and in New Jersey. At Harrison, N. J., and Jamaica, L. I., there are to be interchange yards, where the steam locomotives of through trains are replaced by electric locomotives for the run through the tunnel section. The Manhattan station will therefore handle trains of two classes, namely: Multiple unit suburban trains, and ordinary coach and Pullman trains drawn by electric locomotives. The Thirty-third street side of the station and the Thirty-third street tunnels have been designed for use principally by multiple unit trains.

Following its usual custom, the Pennsylvania management appointed a committee to take up this question of terminal yard facilities, decide on a definite location, and formulate a track plan from which detailed drawings could be made and preparations got under way for the work of construction. After various surveys and other investigations, this committee decided on a location in the "Sunnyside" district in Long Island City. The purchase of a strip of land was begun along the Main Line division, commencing about one mile from the East river, and extending eastwardly for two miles; the average width is about 1,500 ft. The plan (Fig. 1) prepared by this committee contained many interesting features. It included an interchange yard with space for motor storage, engine storage, coaling facilities, etc., it being the intention at that time to change the motive power at Sunnyside yard rather than at Jamaica. The yard proper was divided into six sections, and from

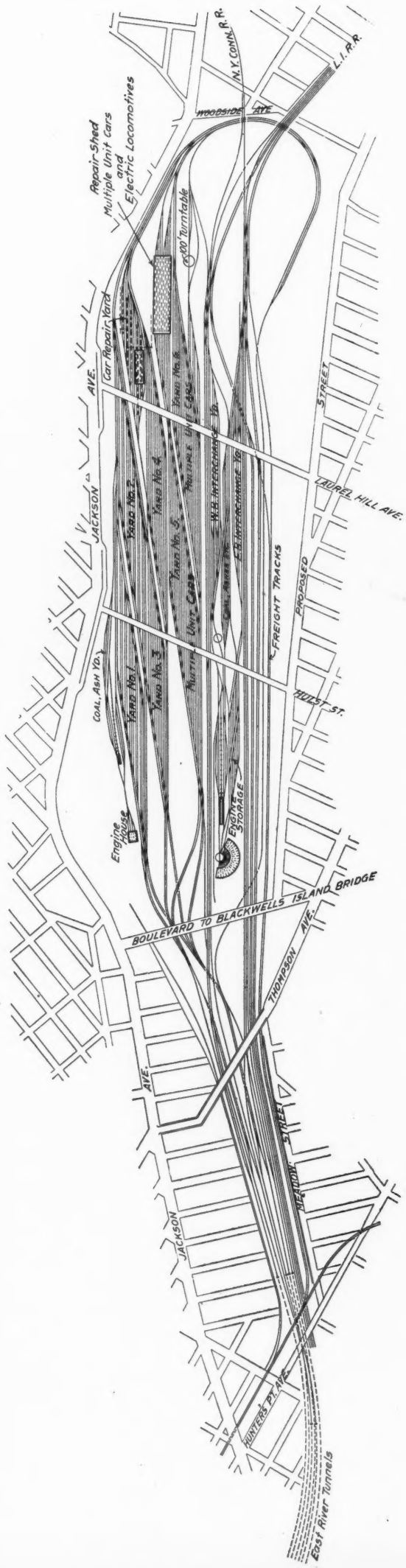


Fig. 1—Sunnyside Yard at Long Island City, As Originally Planned; Pennsylvania Railroad.

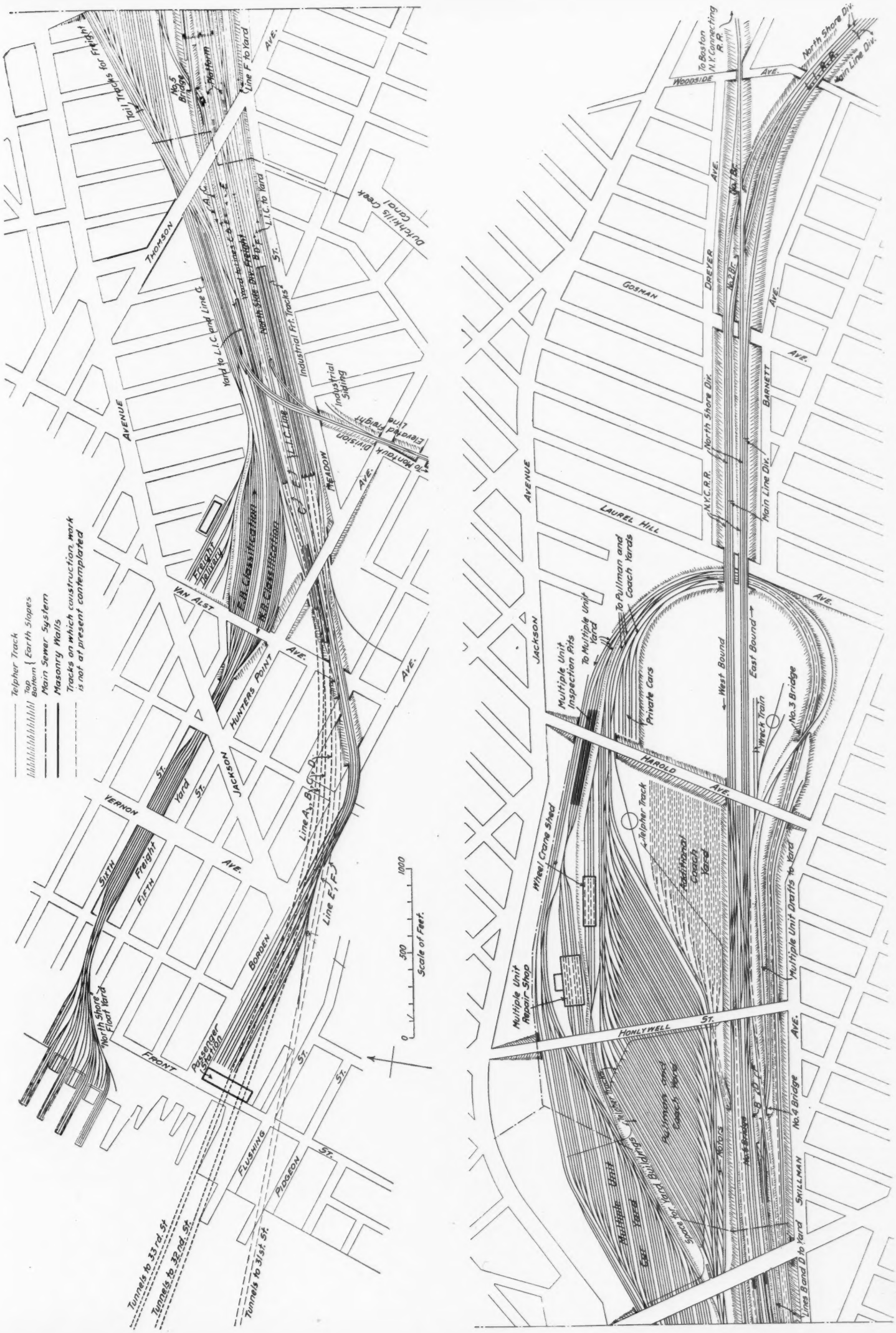


Fig. 2—Present Plan for Passenger Terminal Yard at Long Island City.

the head or westerly end of each a double-track line leads to the eastbound and westbound main tracks respectively, grade crossings being avoided by the use of track bridges. These sections were as follows: Two for Pullman cars, having a total capacity of 340 cars with an average of 17 to a track; two for coaches, having a capacity of 375 cars, with 20 to a track; and two for multiple unit cars having a capacity of 700 cars with 24 to a track. In the multiple unit sections, all tracks and ladders were to be electrified; in each of the Pullman and coach sections, all running tracks and ladders, and two yard tracks were to be electrified, it being intended to use these two yard tracks for receiving drafts from the Manhattan station, the cars to be thence shifted and distributed by steam switch engines. This plan provided also a single-track connection leading around a three-track loop to the easterly end of the yards, so as to turn complete trains around. The work included, among other things, 14 distinct track bridges and about a mile of waterproofed subways as approaches to the tunnels. The total first cost was estimated at about $10,000,000.

Negotiations with the city authorities were under way when the idea presented itself that the number of track bridges and the length of subways were rather excessive; also that the ground occupied (some 280 acres) was somewhat large for the storage of only 1,400 cars. After a decision by the late President Cassatt, a new plan was adopted, providing for a yard about 5,500 ft. long and 1,550 ft. wide at its widest point. This has been developed as shown in Fig. 2.

This new plan was made up in accordance with a basic change in the method of operation. The yard tracks were, so far as possible, made continuous, rather than stub end; that is, nearly all drafts will be taken around the loop, entering at the easterly end of the yards and leaving at the westerly end. This will keep all yard traffic moving in the same general direction, avoiding many conflicting movements and lessening the danger of collision. The interchange yard was eliminated, satisfactory evidence having been produced to show that a saving in time of operation could be made by locating it at Jamaica. The idea of using steam switch engines was abandoned and it was decided to operate the whole yard electrically. All crossings of tracks at grade were avoided by the use of track bridges. A freight classification yard, having a capacity of 400 cars, was provided for and has been located just north of and adjacent to the tunnel portals about half a mile from the East river. From here nearly all freight will be carried by means of a Y or switchback along the north side of the passenger yards to an elevated line crossing the passenger tracks and running southward for about half a mile to a junction with the Montauk division. The passage of freight through the Sunnyside yard is thus avoided.

An investigation of the present passenger yard facilities at both Jersey City and Long Island City produced the following working information: At Jersey City there are two yards: the Waldo avenue, which is situated about 1½ miles from the station, and the Jersey City, which is adjacent to the station.

Waldo Avenue Yard.

No. of tracks	27
Capacity of yard	320 cars.
No. of cars per track, varies from 2 to	20 "
Max. No. of cars in yard at one time	250 "
" " Pullman cars in yard at one time	110 "
" " Penn. R. R. cars in yard at one time	140 "
Average No. Pullman cars per 24 hrs.	160 "
" " Penn. R.R. cars per 24 hrs.	160 "
Maximum No. Pullman cars per 24 hrs.	210 "
" " Penn. R.R. cars per 24 hrs.	175 "
No. of wheel tracks	2
Time at which maximum number of cars are in yard, 9 to 10 a.m.	

This yard is used exclusively for through line and Pullman business, no attempt being made to separate the Pullman or dining cars from the coaches. The yard people think this is as it should be and also consider that a track holding 12 cars and one engine, or about 900 ft. long, is the most suitable length, even though the make-up sheet shows that few trains carry more than eight cars.

Jersey City Yard.

No. of tracks	13
Capacity of yard	158 cars.
No. cars per track, varies from 4 to	17 "
Maximum No. of cars in yard at one time	175 "
" " coaches in yard at one time	115 "
" " express cars in yard at one time	31 "
" " mail cars in yard at one time	30 "
Average No. of express cars per 24 hrs.	40 "
Average No. of mail cars per 24 hrs.	37 "
Time at which maximum number of cars are in yard	3 p. m.

This yard is used for local, mail and express service. It is very much congested and to properly handle the present business should have a capacity of 275 cars. The yardmaster recommends tracks having a capacity of 15 cars and a locomotive, or about 1,050 ft. long, his idea being to handle two trains on one track. It is probable that 65 per cent. of the suburban service to Jersey City will continue to be handled at that point either by the present ferry or by the Hudson & Manhattan tunnels.

At Long Island City there are three yards.

Yard No. 1.

No. of tracks	20
Total capacity of yard	285 cars.
Capacity of longest track	15 "
Capacity of shortest track	8 "
Maximum No. of cars in yard at one time	285 "
Time at which maximum No. of cars are in yard	11 a. m.

This yard handles the North Side division and through business.

Yard No. 2.

No. of tracks	5
Total capacity of yard	50 cars.
Capacity of longest track	15 "
Capacity of shortest track	5 "
Maximum No. of cars in yard at one time	50 "
Time at which maximum No. of cars are in yard	11 a. m.

This yard handles all the local business excepting the North Side division.

Yard No. 3.

Total capacity of yard	50 cars.

This yard is used to store race trains and is always filled except during racing hours.

During the maximum 24 hours, 556 cars run out of Long Island City. At 11 a.m. there are 450 cars in the yards, 45 of which must necessarily stand on the station tracks. The yard people here recommended tracks having a capacity of 12 cars each.

TRACK SPACING.

Both the Pullman and Pennsylvania yard people agreed that tracks in the through coach yard should be spaced with alternately wide and narrow platforms, planking to extend to the rail and level with it; the narrow spacing leaving 6 ft. between cars and the wide spacing 15 ft. The wide platforms are covered by a shed with roof extending over the lower decks of the cars. These spacings mean that tracks are 16 ft. and 25 ft. apart, center to center, respectively. In the local yard a space of 4 ft. between cars, i.e., 14 ft. center to center of track, is considered ample.

WHEELING FACILITIES.

In the opinion of the yard men, each wheeling track should be long enough to let five cars be worked at once, tracks to be spaced 25 ft., center to center, and each track to have a pit under it. An overhead traveling crane should be provided, together with space for storing wheels and facilities for turning wheels and axles.

PIPING IN YARDS.

The coach and Pullman yards should be piped with separate lines for steam, gas and water, and also air for cleaning and for

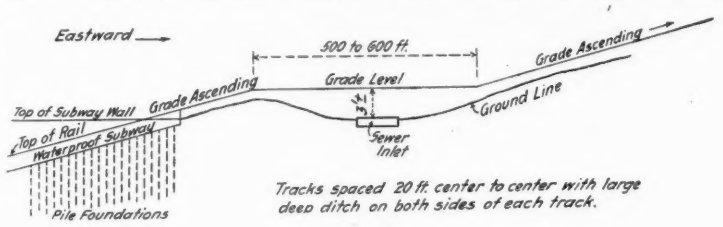


Fig. 3.

brake testing; there should be, also, outlets for charging electric storage batteries. Details are as follows:

Steam: Locate outlets at both ends and middle of all tracks.
Water: Pipe all tracks with 100 ft. between plugs.
Gas: Pipe all tracks with 100 ft. between plugs.
Air for cleaning: Pipe all tracks with 100 ft. between plugs.
Air for testing: Locate outlets at both ends and middle of all tracks.
Battery charging: Wire all tracks with 65 ft. between plugs.

BUILDINGS.

The carpet cleaning shed should have platforms 15 ft. by 75 ft., and about 4 ft. above the ground; the vacuum cleaning system is considered preferable to the blower system. The following table shows the present floor space at the Waldo avenue yard, where 700 men and 30 women are employed; also the floor space required to properly perform the work:

Pullman Store-Room Space and Requirements.

	Present.	Required.
Heavy material storeroom	800 sq. ft.	1,100 sq. ft.
Miscellaneous storeroom	2,500 "	3,800 "
Clean linen storeroom	1,500 "	2,600 "
Soiled linen storeroom	2,000 "	4,000 "
Cleaners' equipment storeroom	360 "	900 "
Plumbers' storeroom	360 "	900 "
Carpenters' storeroom	600 "	1,200 "
Carpet storeroom	700 "	1,100 "
Record storeroom	600 "	1,200 "
Porters' storeroom	750 "	1,200 "
Commissary storeroom	3,600 "	7,200 "
Supt. and foreman's office	360 "	900 "

If the soiled linen is placed on the second floor, an elevator for raising and a chute for lowering the linen should be provided. Ample toilet facilities should be provided throughout the building, the porter's room having separate toilet and bath facilities. The refrigerating boxes in the commissary should be cooled by refrigerator plant rather than by icing.

Pennsylvania Railroad Buildings.

	At present.	Required.
Battery house	1,850 sq. ft.	5,500 sq. ft.
Maintenance-of-way storeroom	8,500 "	14,400 "
Carpenter shop	1,000 "	1,400 "
Carpet room	720 "	720 "
Steamfitters' room	750 "	1,500 "
Air-brake room	240 "	240 "
Tinsmiths' room	375 "	500 "
Officers	600 "	1,200 "
Yardmasters' office	450 "	900 "

The following amounts of waste, cleaning and lubricating oils

are used per month, and a suitable building should be provided for the storage of the same together with about 300 sq. ft. each for Pennsylvania Railroad and Pullman paints:

	Used.	Storage-room required for:
Pullman cleanzine	40 bbls.	80 bbls.
" kerosene	30 "	60 "
" cotton waste	16 bales.	30 bales.
Penn. R.R., cotton waste	5 "	10 "
" " woolen waste	1½ "	3 "
" " Galena winter oil	40 bbls.	60 bbls.
" " Galena summer oil	40 bbls.	60 bbls.

The general sentiment of all the yard people is opposed to narrow gage tracks for trucking purposes between the standard gage tracks. It is also agreed that a single post inverted umbrella shed is preferable to any other type.

ELECTRIFIED SERVICE.

There are at present about 150 motor cars and trailers in the Long Island Railroad electric service. The officials in charge of this equipment recommend a spacing of 14 ft., center to center, of track for the multiple unit storage yard, thus giving 5½ ft. between cars.

INSPECTION PITS.

The motor cars are inspected on a mileage basis, cars going over the pits after having run 750 to 800 miles on the road. With the present service, this averages once in four days. The pits now in use have a capacity of four cars each, all light repairs being made while the cars are over the pits. Owing to the excessive weight of the motor cars and trucks, heavy work, such as wheeling, or repairing motors, is done at the repair shops. Pits having standing room for seven cars are recommended so that an entire train can be inspected over one pit. The pits now used are of concrete, 42½ in. deep from top of rail to bottom of pit, bottom being slightly

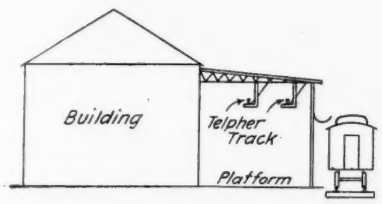


Fig. 4.

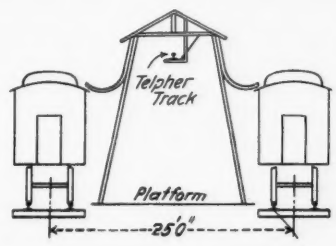


Fig. 5.

concaved. The pits are lighted, piped with air which is used for blowing motors, and are steam heated. There is no third rail along the pits, current being delivered through an overhead trolley. Tracks on the inspection pits are spaced 14 ft., center to center.

From the above mentioned investigation, it will be seen that, in order to handle business of an amount equal to that carried at present, yards must be provided having a capacity of at least 840 cars, about 500 of which are used on through service. In the course of a very few years, all the local or suburban trains will be made up of multiple unit equipment and consequently have been considered as such in the design.

In developing the plans for the Sunnyside yard and contemporary improvements, the following general ideas were kept in mind and the design made to conform thereto: Separation of multiple unit equipment from ordinary coach and Pullman equipment; main tracks separated from the yard proper and the running tracks leading thereto, by being placed on a different level; no crossing of running tracks at grade; all switches to be designed so as to allow as many parallel movements as possible without unduly complicating the track situation or greatly increasing the cost; running tracks and connections between the main tracks and yards arranged so as to allow an alternative route for each movement, these alternative routes being widely separated so as to prevent the yards being tied up and blocked by a serious derailment or wreck occurring at any particular point. In the design of the Sunnyside yard and the Manhattan station provision has been made for two additional tunnels under the East river, which, when built, are to run under Thirty-first street, Manhattan. The city of New York has required the construction of two viaducts carrying streets over the yard approaches, one over the freight yard, and three over the Sunnyside yards proper; also three bridges carrying the main tracks over streets east of the yards, as well as the elimination of several grade crossings on the Long Island City passenger line.

Approaching the Sunnyside yards from the west there will be 10 main tracks, four from the Long Island City station and six from Manhattan by way of the river tunnels. At the easterly end of the yards there will be eight tracks, four leading to the Main Line division, two to the North Side division, and two to the New York Connecting Railroad. These main tracks meet and are joined by a system of interlocked switches, so arranged as to allow three trains to pass in each direction at the same time. In connection with these switches, connections will be provided whereby an occasional interchange of steam and electric locomotives may be effected. Throughout the limits of the Sunnyside yard, all westbound main tracks lie together and all eastbound tracks together. This track arrangement was made possible by a crossing of the tunnels between the portals and the river on the west, and an arrangement of two-track bridges on the east. From the portals eastward all tunnel tracks are in waterproofed subways to a point where the top of rail is 8 ft. above the mean high tide level. Just beyond the ends of these subways the tracks have been so graded as to prevent surface water from draining towards the subways and tunnels. This was accomplished as shown in Fig. 3. Beyond these points, which are in the vicinity of the Thomson avenue viaduct, all main tracks are carried eastward on a rising grade, thus passing through the yards on a level some 20 ft. higher than the yard tracks. A station is contemplated just east of Thomson avenue, whereby passengers may transfer to the trolley cars or other transit facilities which will be in operation over the Blackwell's Island bridge. The general principles followed in making plans for main tracks are as follows: Standard spacing of 13 ft., center to center, wherever possible; no masonry walls or abutments placed closer than 8 ft. from center of track to face of masonry; all grade tangents connected by vertical curves having a radius of 30,000 ft. or more; horizontal curves kept as low in degree as possible and easements provided in case of a curve sharper than 2 deg. 30 min.; No. 15 frogs used for all connections in the main tracks.

Near the subway-ends are connections from the main tracks to running tracks which lead to and from the yards. The eastbound running tracks pass along the southerly side of, and on a lower level than the main tracks, leading thence around the loop to the easterly end of the yards. Provision has been made for the ultimate construction of four loop tracks, one from each of the New York lines and one from Long Island City. In addition to the loop tracks these will be, ultimately, a double-track connection to the yards passing under track bridge No. 6 as shown in Fig. 2. Previous to the construction of No. 6 bridge, a single-track emergency connection will lead from the westbound main tracks at the interlocking plant down along the embankment so as to connect with the yard tracks adjacent to the motor storage space. On the plan in Fig. 2 the following points of interest should be noted: Running track heading to loop from line B (Thirty-third street, eastbound) is crossed over other loop tracks, thus affording a route for multiple unit traffic to the yard, independent from the routes used by coach and Pullman or combination traffic; an emergency connection from main eastbound tracks to this multiple unit running track near bridge No. 3; an emergency connection located west of Line A portal between Line C (Thirty-second street, westbound) and running track to Long Island City. On the loop is a system of switch work whereby drafts may be passed to either the multiple unit section or the coach and Pullman section of the yards.

From the loop switching plant, multiple unit equipment may be sent direct to the storage yards or may be diverted to the inspection pits, whence it may pass on to the storage yards or, again, be diverted to the repair shops. The multiple unit storage yard will, ultimately, have 42 tracks, each with 800 to 900 ft. of clear standing room, thus giving a total capacity of 550 cars. These tracks are divided into seven groups of six tracks each, the tracks in each group being spaced 15 ft., center to center, with spaces 25 ft. wide between groups. The westerly or leaving ends of these tracks are connected to a double-track ladder, and the easterly or entering ends to a three-track ladder. The reason for three tracks on the easterly end is to provide for some switching movements and also to allow drafts to leave the yard by these easterly ladder connections, as would be necessary in case of a movement to line E (Thirty-first street, westbound). The spacing of 25 ft. between groups of tracks was necessary to allow the introduction of slip crossings in the near ladder without fouling the adjacent track in the next group.

The coach and Pullman storage yard consists of 11 tracks, spaced alternately 25 ft. and 16 ft., center to center, and 35 tracks divided into groups of six tracks each with a spacing of 14 ft., center to center, between the tracks of each group and 19 ft. between groups; these tracks vary in length from 950 to 1,100 ft. of clear standing room and have a total capacity of 600 cars. The southerly or leaving ends of these tracks are connected to a three-track ladder, the far track of which serves to connect with a small storage space for electric locomotives or motors. The northerly or entering ends of these tracks are connected with a ladder increasing from one to five tracks as the number of storage tracks connected thereto increases. While the general design of the Sunnyside yards is such that much switching of cars will be avoided, yet it has been thought best to provide the above-mentioned five ladder tracks with connections which will let a considerable number of switching movements be made without interfering with the movement of drafts entering the yard. It is the intention to equip at least one track in each group with inspection pits. With a track

spacing of 14 ft., center to center (15 ft. where column foundations for viaducts are introduced) it will be noted that by removing each third track and lining over each second one of the remaining two, a spacing of 26 ft. and 16 ft. may be obtained, thus affording a ready means of increasing the number of wide spaced tracks should traffic conditions require it. A yard for private cars, with a time-table, has been provided as shown on the plan.

A portion of the space within the loop has been utilized in the design for an additional storage yard, having stub end tracks with a total capacity of 350 cars. The construction of this yard is not contemplated for some years as yet. Throughout the yards, all ladders and running tracks have been spaced 13 ft., center to center, and all connections have been designed for No. 8 frogs except at the loop switching plant, where a few No. 10's and No. 12's were found necessary.

The various yard buildings will be in the space lying between the multiple unit section and coach and Pullman section of the yards. There will be stairways for the use of yard employees leading from these spaces to two of the street viaducts crossing the yard; also an incline driveway leading to the Honeywell street viaduct. Among the various buildings contemplated are the following: Pullman store building, motive power store building, Pennsylvania Railroad service building, storage battery house, bunk house for yard men, carpet cleaning sheds, wheel crane shed and crane, multiple unit inspection sheds, multiple unit repair shops, car inspector's building, oil house, air compressor plant, heating plant, pump house, yardmaster's office.

In excavating near the space set apart for multiple unit repair shop, a very good supply of water has been found. It has been decided, therefore, to build a reservoir located south of the main tracks and within the loop, thus placing it high enough to supply by gravity flow the whole yard and also the Long Island City power house. A pump house and wells are to be located near the Honeywell street viaduct and within the space for buildings.

In a yard so large as that to be built at Sunnyside, the problem of handling supplies, etc., is quite serious. In this case, a system of telpher tracks has been designed whereby the overhead single-rail trolley, or telpher, can be used to meet this need without in any way interfering with the train movements or other operations of the yards. These telpher cars are to carry linen, storage batteries, commissary and other supplies, and even employees, back and forth between the yard buildings and the various tracks. The layout of telpher tracks is shown in Fig. 2, and the methods of supporting them are as in Figs. 4 and 5.

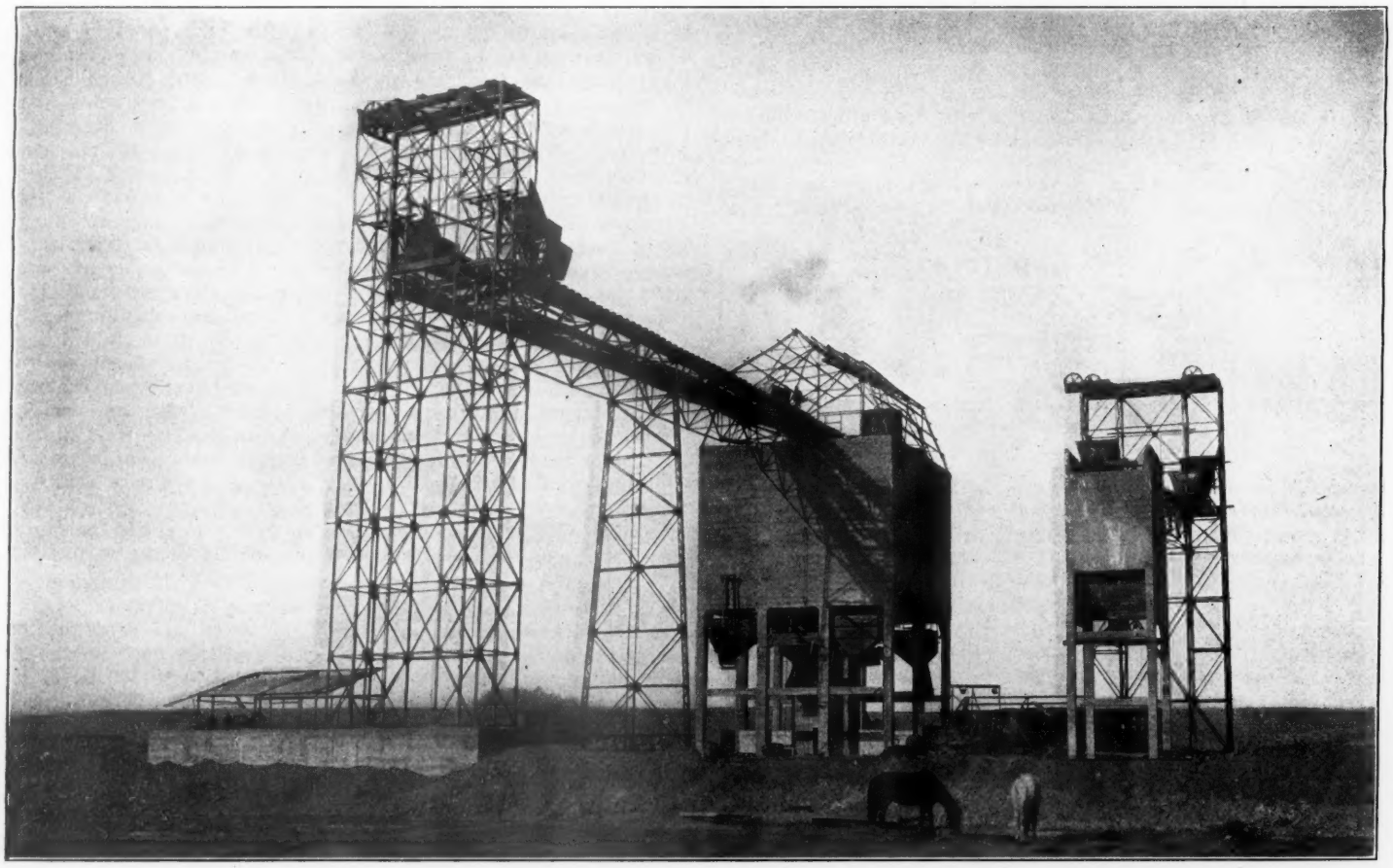
Construction of the Sunnyside yards and approaches was commenced about January 1, 1907, and the yards will probably be put in operation some time during the year 1910. The construction requires the moving of 3,000,000 cu. yds. of earth, the driving of 300,000 lineal feet of piling, the erection of 200,000 cu. yds. of concrete masonry and the laying of some 73 miles of track. The estimated cost is about $7,000,000.

Coaling Stations on the Belen Cut-off.

Illustrations are shown herewith of the locomotive coaling stations on the Eastern Railway of New Mexico, better known as the Belen cut-off of the Atchison, Topeka & Santa Fe, which was recently completed between Belen, N. Mex., and Texico, on the Texas-New Mexico boundary.

The terminals for the eastern end are located at Clovis, N. Mex., 10 miles west of Texico, where the conditions were particularly favorable for a model arrangement. The coaling plant, which is shown on page 347, is built of reinforced concrete and steel. The bin has a storage capacity of 750 tons and four tracks are served, two outside and two underneath. The bin is filled by a belt conveyor. The receiving track is 250 ft. away, has room for 10 cars and is sloped 1 per cent. for ease in moving the cars across the hopper. The elevating capacity of the belt is 120 tons an hour. The incline for the belt conveyor is of steel frame construction and the roof trusses over the bin are steel. All siding and roofing on the plant is "asbestos protected metal."

Coal is weighed in steel hoppers suspended on a special "Buffalo" pipe-level scales, having plus and minus beams and a type registering device to record on the coal ticket the exact weight of coal taken on a locomotive.



Coaling and Cinder Plant at Belen, N. Mex., Under Construction; Atchison, Topeka & Santa Fe.

In addition to the coaling plant is a novel cinder handling plant, seen at the right in the photograph. Underneath the two tracks passing under the coal pocket are cinder pits lined with fire brick. Between these two pits is a hoisting tower of steel construction in which travels a pair of large Holmen buckets. These buckets automatically operate gates which deliver the cinders to the buckets. At the top of the tower the buckets automatically deliver their load to steel-lined cars working in time with the elevator and operated by it, a system recently patented. These cars, which dump and close automatically, deliver the cinders to a concrete storage bin a short distance from the elevator, arranged to deliver to railroad cars underneath. Both the cinder plant and coaling plant are worked by electric motors.

In connection with the coaling plant is a reinforced concrete sand storage bin. The sand is elevated by the belt conveyor and discharged into a bin under the coal pocket. A stove dryer and screens are so arranged that the sand is dried and screened without hand labor. The dry sand is raised by compressed air.

At Taiban, 45 miles west of Clovis, is the coaling plant shown

herewith. This is a wooden frame plant of 250 tons storage capacity. The coal is elevated by means of large Holmen buckets in the usual manner. Another plant is located at Yesso, 42 miles west of Taiban, and is a duplicate of the Taiban plant in all respects.

The next plant is at Vaughn, 43 miles west of Yesso. There is a novel feature connected with this plant, which is also shown. The coal is received on a track about 48 ft. from the storage pocket. A Holmen elevator and Barrett automatic tram car system is used to convey the coal to the storage pocket as described for the cinder plant at Clovis.

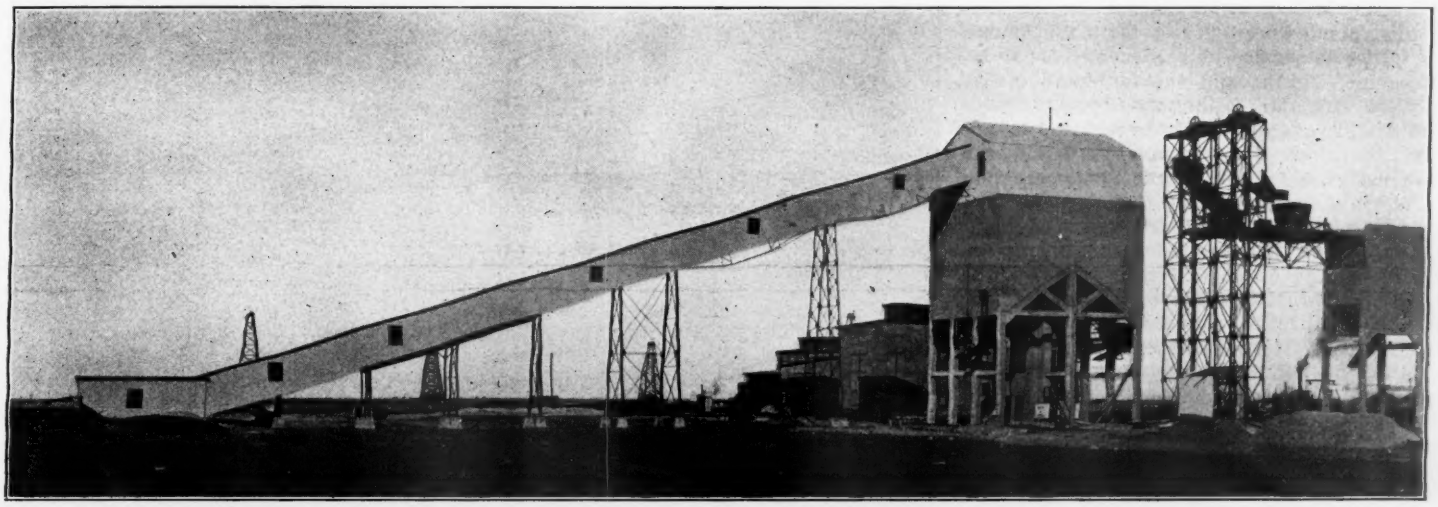
A sand plant is also a part of the equipment at this place. The sand is elevated in the Holmen buckets and discharged into a reinforced concrete bin between the elevator tower and the coal bin. The sand gravitates through a stove dryer, over screens and into a steel drum from which it is blown to the dry sand bin by compressed air.

car system it is delivered to the coal bin, 135 ft. from the receiving track. Two kinds of coal are handled here and to prevent their getting mixed, the receiving hopper is divided into two parts. One Holmen bucket handles the coal from each hopper and the tram cars deliver the coal independently to their respective bins. A Holmen-Barrett cinder plant here is a duplicate of the Clovis plant.

With the exception of the Clovis plant all the plants are equipped with the weighing hoppers mentioned with the Clovis plant, and all but this plant are driven by "Ohio" gasolene engines.

The plants were all designed and built by Roberts & Schaefer Co., Chicago.

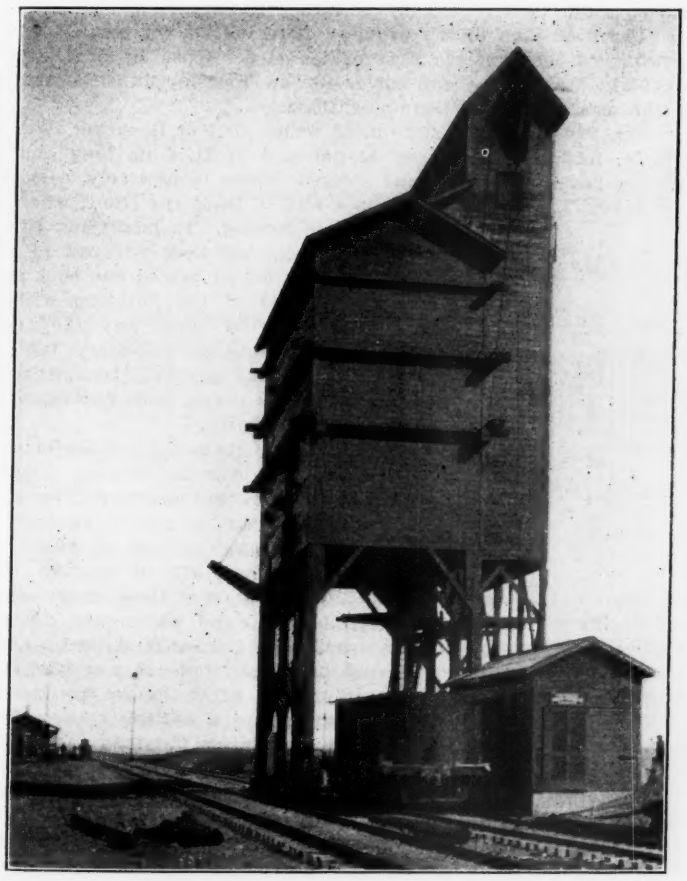
A molder employed in the Baden State Railroad shops at Karlsruhe was elected on the Social Democratic ticket a member of the city common council. The railroad authorities informed him that if he accepted this office he would be discharged from the State Railroad service. In the Baden Parliament Social Democratic members declared this notice to be in contravention of a citizen's rights. The Prime Minister answered that the action of the government was due to the fact that the Social Democratic party regards as one of the most important means of obtaining its ends strikes by workmen, and especially by railroad men. The State Railroad management is responsible for the regular and uninterrupted operation of the railroads in the interest of the public at large, and cannot keep in its service any man who openly declares that it may become his purpose to prevent such regular and uninterrupted operation.



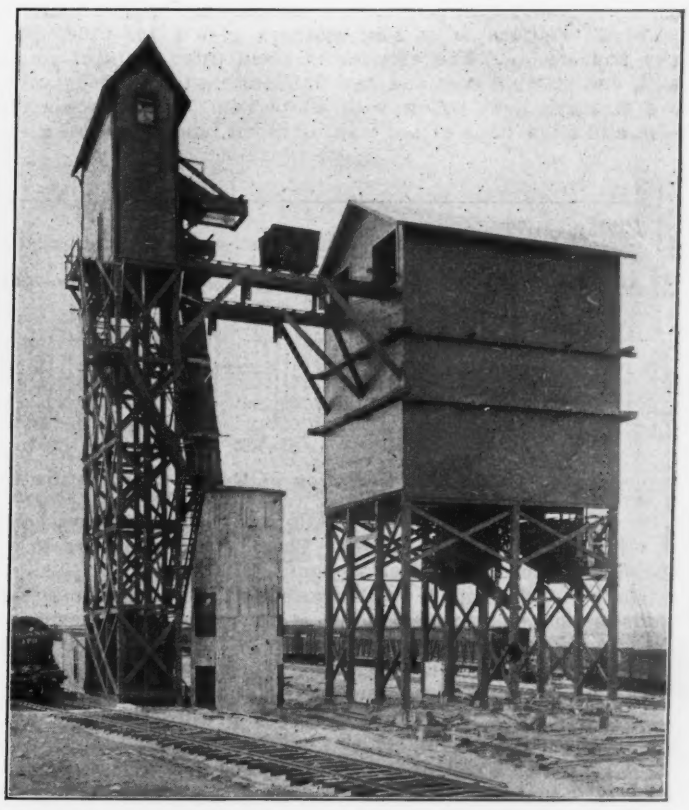
Coaling and Cinder Plant at Clovis, N. Mex., on Belen Cut-Off of the Atchison, Topeka & Santa Fe.

A coaling plant at Willard, 55 miles west of Vaughn, is a duplicate of the ones at Taiban and Yesso. Another at Becker, 39 miles west of Willard, is also a duplicate of these in general design, but of 350 tons capacity.

The plant at Belen, the western terminus (page 346) is like the one at Clovis, except in the method of elevating coal. This is done in Holmen buckets, and by means of the Barrett automatic tram



Coaling Plant at Taiban, N. Mex.; Belen Cut-Off.



Coaling Plant at Vaughn, N. Mex.; Belen Cut-Off.

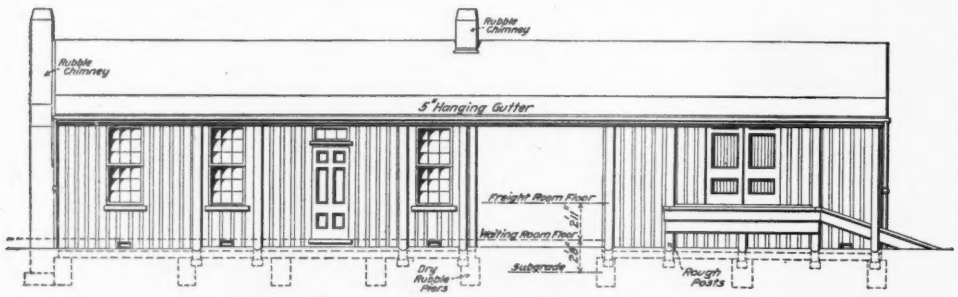
Station Standards; Virginian Railway.

In the previous articles (see *Railroad Gazette* of March 15 and August 23, 1907, under caption "The Tidewater and the Deepwater Railways") the general features of the road and the methods of track and bridge construction were considered. The same system of standardization that has already been outlined has been carried on to other departments of the work.

It is not often, however, that railroad standardization is carried to such an extent as to include the station buildings and section men's houses, so that they can be built and located where desired, without further attention from the engineering department. This has been done in this instance, and is working successfully. The plans, as prepared, could only be made applicable to places where the conditions to be met are practically uniform; but as there are no large towns along this line, the plans are applicable to nearly every place upon it. The original plans were of three main types; one for towns of considerable size; one for small places in Virginia, and one for small places in West Virginia. Later it was found that a modification of these would be required in certain localities. For example, new stations were designed for use in the tobacco section of Virginia for both large and small towns; and, in West Virginia there has been a revision of the plans for small towns. The reason for the distinction made between the two states is that the laws of Virginia require separate waiting room accommodations for white and colored people, while those of West Virginia do not. The first design of station for large towns is 80 ft. long by 22 ft. wide. The second is 70 ft. long by 26 ft. wide, and both are combination freight and passenger stations. The original station for small Virginian towns contains waiting rooms for white and colored passengers and a ticket office and a freight house and measures 60 ft. by 22 ft. That for West Virginia has but one waiting room, the ticket office and freight house, and measures 40 ft. by 16 ft.

Station at Mullens, W. Va.; Virginian Railway.

Of the smaller sized stations of the original design that at Mullens, W. Va., is typical. It is a frame building and the specifications permit that the rough framing shall be of either white, Norway or southern pine, spruce, Pennsylvania white hemlock or fir, provided only that it is sound and free from defects. The interior finish is in natural wood, kiln dried and varnished on the exposed surfaces. The flooring of the offices and waiting rooms is of quarter sawn Carolina pine or maple of 2½ in. face and ⅞ in. thick and matched for the whole length. The baggage and freight house flooring of all stations is of 2-in. southern pine 6 in. wide, quarter sawn and smooth. The exterior is given three coats of standard paint, one priming coat and two finishing coats, the body color to be a standard light yellow with white trim. Six settees are provided along the walls of the waiting rooms, and these are made of ⅞-in. oak or ash slats with V joints screwed to cast-iron brackets or supports of the form shown. These specifications as to finish also apply to the larger sized stations.



Side Elevation of Rustic Combination Station.

In the Mullens and similar stations the waiting room has an inside measurement of 10 ft. by 14 ft. 10 in., or the full inside width of the building; the ticket office has a width of 6 ft. 6 in. and the freight house 21 ft. 4 in. The latter has sliding doors at the front and back and, on the track side, has a gangway of 4-in. planks for an approach. In the second design of "rustic stations," as they are called, the total plan of the building covers an area of 62 ft. by 16 ft. with an operator's window at the ticket office end projecting 5 ft. 6 in. on the track side. This projection is merely the extension of the ticket office out to the edge of the overhang roof of the platform. This roof is carried at its outer edge by eight round wooden columns. The ticket office at one end has a width over the partition walls of 11 ft. and extends the whole width of the building. The total length of the ticket office and waiting room section of the building is 34 ft., of which the waiting room occupies 23 ft. Beyond this is an open driveway 11 ft. wide and then a freight room occupies the remaining 23 ft. of the plan. The floors of these freight rooms are either on the ground or raised 2 ft. 11 in. above the level of the waiting room floor. The intention is to use the rustic station with an elevated freight floor in the tobacco country of Virginia, while that with a low floor will be used in West Virginia. The interior finish of these stations is essentially the same as that of the design already described. Externally they have a rubble chimney for both the ticket office and waiting room, which gives them the characteristic feature of the other buildings of the country, and it is the intention to plant climbing vines about the one at the end of the building. This will be an innovation and add to the attractiveness of the structure.

The floor plan of the 60-ft. by 22-ft. station for small towns in Virginia is the same as that of the larger 80-ft. by 22-ft. station, except in dimensions, and the inside and outside finish is like that of the smaller West Virginia stations.

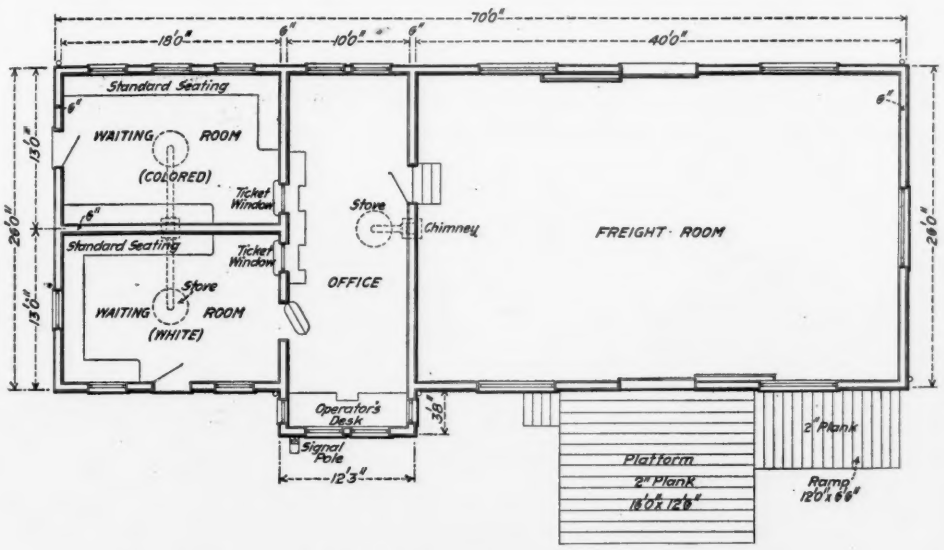
The 80-ft. by 22-ft. station, of which that at Brokneal, Va., is a sample, has a freight room at one end 34 ft. 6 in. long and two waiting rooms for white and colored people respectively, each with a width of 21 ft. 9 in. at the back and 16 ft. at the front, where the ticket office is located. In modifying this design, the building has been widened to 26 ft. and the waiting rooms placed one back of the other at one end of the building with the ticket office between them and the freight room. These stations are also frame buildings erected to the same general specifications as the smaller stations and with the same interior and exterior finish.

In addition to these regular stations that are to be built in towns and villages, a smaller building known as an operator's house has been designed for use at points where it will be necessary to make station or water stops and where no freight will be received. Such a place, for example, as Elmore on the Deepwater section, where there will be an assembling yard and water tank. Here it will be necessary to have an operator and accommodations have accordingly been provided for such passenger traffic as may offer. The outside dimensions of the building are 12 ft. by 30 ft., and it is divided in the plan into two rooms; one a waiting room and one for the operator. The interior and exterior finish is the same as that of the standard stations, and it has the same large opening between the two rooms filled with a wire mesh that obtains in the case of the other buildings.

This standardization of station buildings is possible, of course, only for small towns. For large places special designs would have to be prepared, and this has been done in the case of the road's large places, Norfolk and Roanoke. Here there will be a yard and

a freight house of dimensions suited to the requirements of the cities. The passenger stations have not yet been designed.

The layout of the tracks and building is given on the plan. These are located at the south side of the city at the crossing of the Roanoke & Southern or the Winston-Salem division of the Norfolk & Western. The passenger station will be 40 ft. wide by 150 ft. long and will be approached by a screening driveway from Jefferson avenue along which there is a line of street cars. This street will be raised about 5 ft. to meet the grade of the road. The road is single track and will have a connection with the Norfolk & Western over a 13-deg. curve, and there will be a long passing



Plan of Standard Combination Passenger and Freight Station.

siding in front of the depot, with a track leading off to a double-track siding in front of the freight depot with space left for additional tracks when the traffic offered may require it. Beyond the freight house there will be a number of team tracks as shown. In all of this layout the plans have been prepared for present construction and future extension.

The freight depot, as designed, will have a width of 40 ft. and a length of 231 ft., of which but 134 ft. 11 in. will be built at present, and the remainder added when the requirements of the traffic shall demand it. The part to be built first will be the east end and will include the offices. The building is to be of brick set on concrete foundations of 1-4-7½ mixture except around the basement beneath the offices, where a 1-3-6 mixture is to be used. Provision is made in these foundations for expansion and contraction due to variations of temperature by the use of vertical tarred paper joints. The piers for the posts supporting the freight house floor are also of concrete

platform will be spaced on 38-ft. centers so that a string of five cars can be spotted in front of the house, each with its door opposite one in the house. Scales will be placed near the center of the floor of the first section to be built, and this will be completed with a brick end wall, which will afterwards form a brick firewall extending up through the roof.

A basement with a headroom of 8 ft. will be located beneath the offices and will be used as a heater room. The floor of this space will be of waterproofed, reinforced concrete on a screening foundation, the whole having a thickness of 21 in.

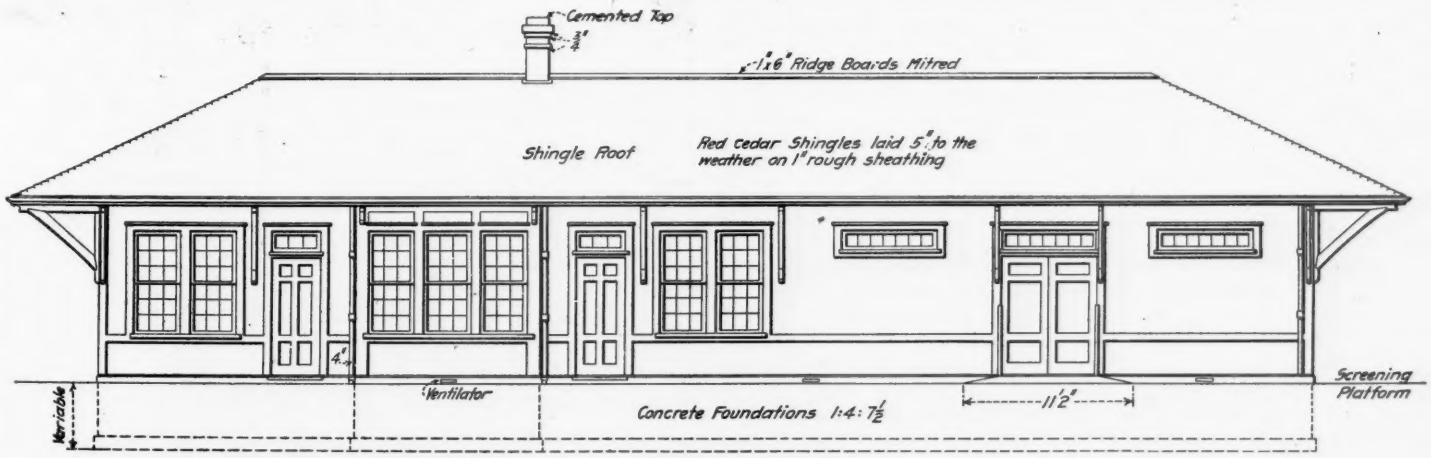
The roof is carried by a simple wooden truss and the whole floor space will be clear and unimpeded by columns. These trusses are spaced on 19-ft. centers. Skylights are put in each slope on 38-ft. centers so that there is ample light admitted from above. The curbing around these skylights is to be of white pine with wooden bars glazed with ⅜-in. ribbed plate, shingled and set in putty with clips. The roof covering will be of No. 1 American Bangor slate laid with a 3-in. lap.

The drainage of the roof water is provided for by five down-spouts on each side. Those on the track side deliver into a 6-in. vitrified sewer pipe that leads down the side of the building to the ends where it empties into 8-in. pipes that run across the ends of the building into a sewer opposite the center of the building and set some distance out from it. At the back corners where the 8-in. pipes turn from the ends, lamp or cleaning holes will be placed, and at the sewer opening there will be the usual manhole and cover. In this way the water from the roof is led away from the foundations at once and the seepage of dampness beneath the building will be avoided, as the pipes are run at a minimum distance of 4 ft. from the walls.

The offices are to be finished in natural wood, with rubbed down shellac, followed by two coats of hard oil rubbed down to an egg-shell gloss.

This is the only large freight house that has, thus far, been designed, as there is no need of so extensive a provision at other points along the line. Work is also in progress on the yard that will be located at Roanoke.

Roanoke Yard.—This yard is the only one of any magnitude that has, thus far, been designed, and even this is small in comparison with other distributing and classification yards that have been built in recent years. The reason for this, at so important a point as Roanoke, is that the traffic that is expected will consist almost exclusively of coal bound for tidewater and originating on the Deepwater section. This traffic will be made up and classified in the Princeton yard, which will be the main point of assembly for the



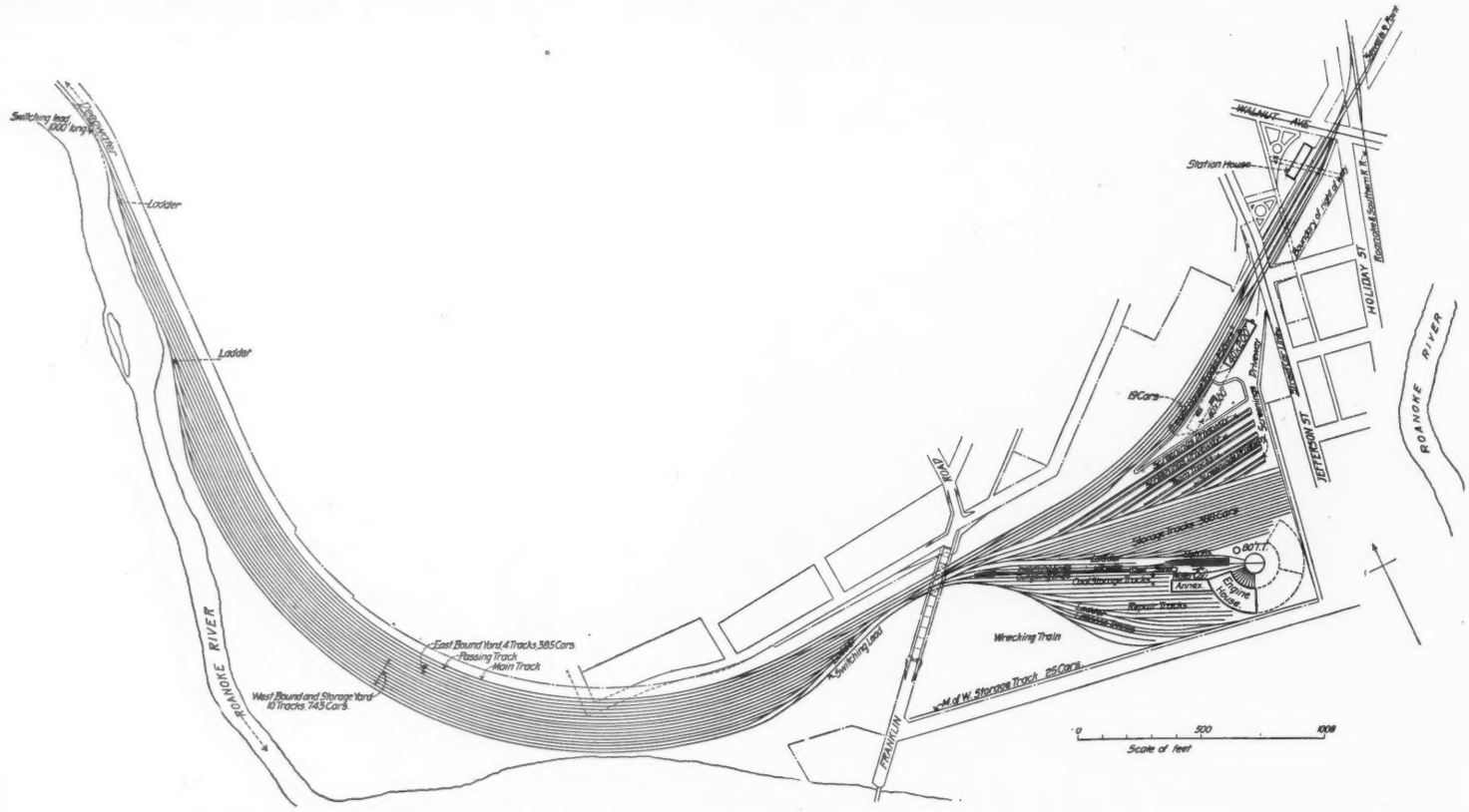
Combination Passenger and Freight Station at Brookneal, Va.

of the 1-4-7½ mixture, and these are spaced on 9 ft. 6 in. centers longitudinally and 9 ft. 5 in. centers transversely. Everything is carried down to at least a foot below the natural surface of the ground, or as much lower as may be required in order to get a good footing. The floor of the freight house is carried on 12 in. x 12 in. posts capped by 12 in. by 14 in. girders, upon which 2 in. by 12 in. joists are laid on 12-in. centers, over which the 2-in. flooring is laid. The top of this floor will be 4 ft. 6 in. above the base of the rail and will have a drop of 2 in. in the slope of the outside platform, so that the latter will be 4 ft. 4 in. above the base of the rail. This platform, which will be on the track side only, will have a width of 8 ft. 2 in. The sliding doors opening upon the

road as well as that from which the empties will be distributed among the mines. Hence both east and westbound trains will for the most part pass through Roanoke without breaking bulk.

The total length of the Roanoke yard is about 7,800 ft. and it is located almost entirely west of the passenger station at Jefferson avenue. The layout is somewhat peculiar and is based upon the exigencies of the case and the topographical limitations imposed. In general the yard follows the bend of the Roanoke river, whose banks it reaches a short distance west of the roundhouse. On entering from the east there is a lead from the main line to the left which runs parallel to the same for the whole length of the yard and forms a passing track. Before reaching the pas-

senger station there is another lead to the left which branches into the double track in front of the freight house already referred to with two extra tracks that may be used for storage. The total capacity of these four tracks from a point east of the freight house to the switches giving access to the team tracks is 114 cars. This team track yard is placed between the freight house and the storage yard and is arranged with double blind-end tracks with a screening driveway approach to one side of each track. These have a total capacity of 126 cars, and beyond, between the team tracks and the roundhouse, is a storage yard composed of 18 blind tracks served by a single ladder track and having a capacity of 300 cars. As will be seen from the engraving, the switching lead for all of these tracks is one running parallel to the main line and extending down into the eastbound yard, where it is to be used as far as the necessities of the string of cars being handled will require.



Plan of Freight Yard and Station at Roanoke, Va.; Virginian Railway.

The roundhouse is to be in the angle formed by the line of Jefferson street and Prospect avenue. At present a house of 10 stalls will be erected but provision will be made for extending it by 20 stalls, making it 30 in all, as soon as it may be needed. The coal trestle, water column and sand pockets are placed between the incoming and outgoing tracks, with ash pits set in the incoming tracks, and these are doubled at that point. The coal pockets have a length of 200 ft. and stand 30 ft. above the tracks, being reached over a trestle on a 5 per cent. grade.

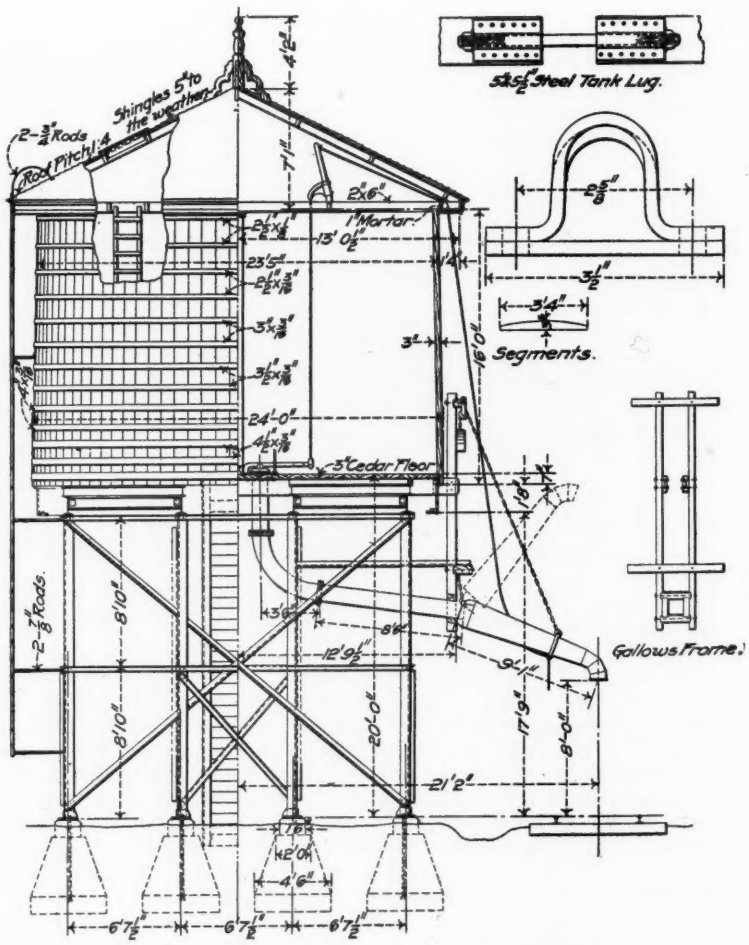
The repair tracks are south of the approach tracks to the roundhouse and are served by a single ladder track that is extended by a switching lead running along the southern side of the main yard and connected with it in such a way that cripples can be taken to the yard and the repaired cars removed and placed in either the east or westbound yards without interfering in any way with the engine movements to or from the roundhouse.

Next to the repair tracks come those for cabooses and the wrecking train. This arrangement of caboose tracks necessitates special switching for the caboose both on incoming and outgoing trains in each direction.

The neck of the yard is formed below the Franklin Road bridge, which is about 3,000 ft. west of the eastern end of the yard or near the middle of the same when it is considered as a whole. At this point there are five tracks; that on the north is the main line, then comes the passing track, then two cross-overs and engine tracks, and last the switching lead for the repair tracks.

The east and westbound yards lie side by side and, except for the arbitrary assignment of tracks to the two, are essentially a single yard consisting of 14 tracks exclusive of the running track at the south side and the passing track at the north, and having a common ladder at each end, that at the west end being run into the passing track and then used as a switching lead. The total capacity of the yard is 1,128 cars, of which 1,385 are assigned to eastbound and 743 to westbound traffic.

The movement of the cars through the yard will be very simple in that, as already explained, there will be very little breaking up of the trains. On entering from the west the trains come in over the passing track and switching lead and in upon the eastbound tracks. The engine is cut off from the train and passes on directly to the roundhouse. The caboose is cut off and hauled back and thence around the running track to the south to the caboose tracks, and whatever classification may be needed will be done over the latter at the east and the running track extending down past the freight station, the cripples being taken out and dropped in on the

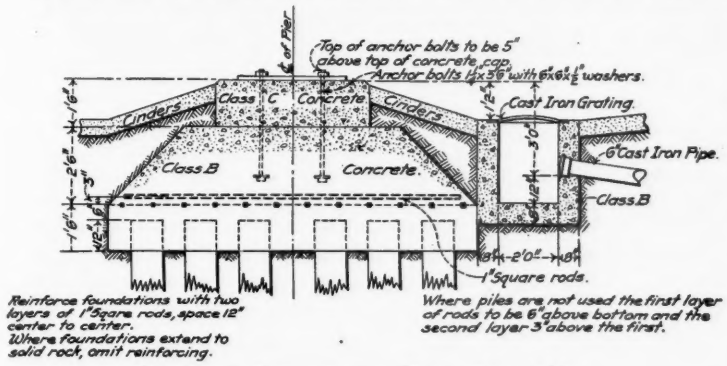


Standard Water Tank; Virginian Railway.

repair tracks to which a direct lead is provided by way of the ladder from every track in the yard.

Entrance to the westbound yard is effected in a similar manner. The train leaves the main line at the first switch and runs over the passing or running track by way of the cross-overs beneath the Franklin road bridge to the yard ladder and thence in upon the westbound tracks. The engine returns to the roundhouse over the running track to the south of the yard and the caboose is cut off and hauled directly back upon the waiting tracks. Classification and the cutting out of cripples is accomplished in the same manner as in the case of the eastbound traffic.

From east to west the yard grade is level as far as the station


Top of anchor bolts to be 5" above top of concrete cap.
Anchor bolts 1¼"x3'6" with 6"x6"x¼" washers.
Cinders
Class C Concrete
Cinders
Cast Iron Grating.
6" Cast Iron Pipe.
Class B
Concrete.
Class B
1" Square rods.
Reinforce foundations with two layers of 1" Square rods, space 12" center to center. Where foundations extend to solid rock, omit reinforcing.
Where piles are not used the first layer of rods to be 6" above bottom and the second layer 3" above the first.

Standard Masonry for 80-ft. Turntable.

when it begins to rise and continues to do so to the western extremity at a rate varying from 0.20 to 0.358 per cent.

The yard is in no sense a classification yard although some work of that character will necessarily be done there, but it is more of a halting place where engines can be changed and cars inspected and repaired prior to their onward movement to tidewater or the mines. For this reason a complication of operation is not provided for as it will be in the case of the great assembling yard at Princeton, which will be dealt with at length in a future issue.

Miscellaneous Standards.—In connection with the station and yard work certain other standards have been adopted that are based upon good American practice and which will serve to simplify the work of the engineering department as already intimated. Among these are standards for water tanks, signals, turntable foundations, crossing signs, methods of running wires, fencing, towers, etc.

One example of these standards is given in the 16-ft. by 24-ft. water tank having a capacity of a little less than 52,000 gallons. As in all other foundation work concrete is used for these tanks, in this case the proportions being 1-3-6. Ordinarily the footings are 4½ ft. sq. but these are increased where the soil is soft. All of these columns are formed of 6 in. by 6 in. by ½ in. angles rising to a height of 17 ft. 9 in. above the rail and there carrying the floor beams, which are made up of 12 in. I's with 8 in. I beam braces. The floor of the tank is made of 3-in. cedar plank, and its upper surface is 7 in. above the tops of the columns, so that it is 20 ft. above the top of the rail. In the general features of the construction the tank does not differ essentially from others of a similar character and is illustrated as an example of good current practice.

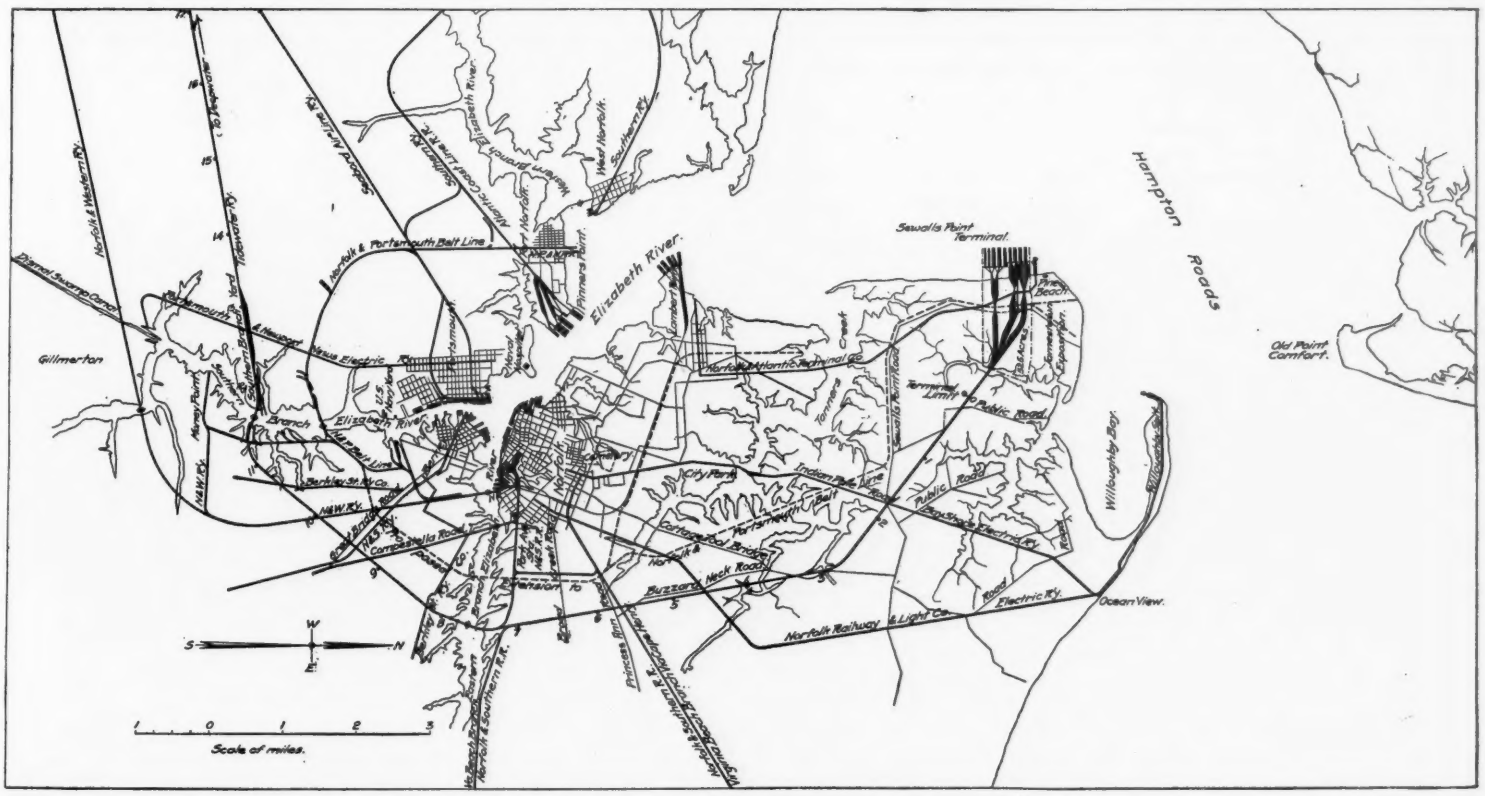
With the design adopted the only flexibility required is in the adjustment of the foundations to the soil upon which they stand, and the same holds true of those for turntables. In that for the 80-ft. table, which is the size adopted, the engraving shows the center arranged to be carried on piles, and these are ordinarily calculated to carry 15 tons. The concrete is of the 1-3-6 proportion as in the case of the water tank piers, and is reinforced with 1-in. square rods spaced on 12-in. centers and in two rows which are 3 in. apart horizontally; the lower rows being 6 in. above the tops of the piles when these are used and projected 12 in. into the concrete.

When piles are not used the lower row of reinforcing is placed 6 in. above the bottom of the concrete, and when the concrete is carried down to a rock foundation the reinforcement is omitted. The foundation is finished with a cap of richer concrete of the C class or 1-2-2 mixture 18 in. thick, upon which the base of the center is to rest.

In the matter of signals the final decision has not yet been reached as to what will be done all along the line, except that it is probable that some system will be adopted whereby a space interval can be maintained between trains. Meantime the details of the signal posts and semaphores have been worked out in accordance with standard practice, being identical with that adopted on the New York Central lines.

In working out these standards allowance had to be made in some cases for the variations in the laws of the two states through which the road runs. These usually make themselves felt in minor details but are of sufficient importance from a legal standpoint to make themselves felt. For example in the case of crossing signs. In Virginia the simple wording "Railroad Crossing" suffices, but in West Virginia there must be added to this the words "Look Out for the Locomotive."

From what has been said in this and previous articles it will be seen that thoroughness in all of the details that go to make up the sum of the construction of the road from the preliminary surveys to the construction of the buildings and tracks has been the watchword of the management throughout.



Map of Norfolk, Va., Showing Railroad Connections and Terminals.

It now remains to say a few words regarding the terminal facilities at the coast. It will be remembered that this road is built with the intention of building up a traffic that does not yet exist and of developing coal properties that have not yet been fully opened.

Further, as there is no market for this coal along the line of the road and the outlet to the west is restricted, it is evident that the seaboard must be the destination of practically all of the traffic that will originate along the line, and that provision must be made to handle it in a coastwise traffic. For this reason no attempt has been made to enter Norfolk over its own lines, but on the other hand, a wide detour carries the line well beyond the limits of the

city and around to the north of the same to the terminal at Sewall's Point. Before reaching the Elizabeth river it runs parallel to the Norfolk & Western, but about two miles to the north, thus skirting the Dismal swamp. A yard will be located on the west bank of this southern branch of the Elizabeth river at the point of crossing of the Portsmouth & Newport News Electric Railway, beyond which it crosses all of the roads centering in Norfolk and then runs down on the sand spit that forms Cape Henry and so reaches Sewall's Point. This point is opposite Old Point Comfort and borders the deepwater of Hampton Roads, but is still sufficiently sheltered to make it possible for vessels to lie securely at the wharves that will be built, without experiencing any inconvenience from the seas that may roll in from the capes outside.

The terminal property as acquired by the railroad was a barren stretch of sand, and on this the heavy wharves and coal handling apparatus will be built. Soundings have been made to determine the qualities of the underlying ground and it is probable that the methods of transferring the lading from the cars to the steamships will be similar to that used upon the lakes, where the cars are lifted and dumped into the hold or weighing hoppers direct without the use of the conveyors or hoists that usually accompany coal-handling plants. It is thought that these car dumps can be made of greater capacity and can handle a large tonnage more expeditiously and economically than a trestle and incline, and for that reason it is probable that they will be adopted. The road will thus be a further exemplification of the predominance of the progressive ideas which it has been shown have controlled every step in its construction from its first inception to the completion of those facilities that will play so important a part in the delivery of its traffic to the markets of the country.

Symmetrical Masonry Arches.

UNIT LOADS AND COEFFICIENTS.

BY MALVERD A. HOWE.

The application of formulas based upon the elastic theory leads, necessarily, to approximate results unless the moments of inertia at all sections of the ring and the curve of the axis are such that the expressions for the horizontal thrust, bending moments at the supports, etc., can be integrated.

In the case of masonry arches it is seldom that the integration can be performed. Summation formulas, however, can be used. These simply mean that the moment of inertia is assumed constant for a finite length of the arch axis and that for this length the axis is a straight line. It is evident then that the shorter the length assumed as straight the more nearly will the results approach the true values.

In applying the summation formulas the method of procedure is as follows. (See Fig. 1.) The span is divided into equal parts (n = 20 will be sufficiently close for most cases) and each part is bisected. At these points the values of the co-ordinates x and y of the arch axis are either computed or scaled from a carefully made drawing. The moments of inertia I of the sections of the arch ring at the points for which x and y have been determined, are next computed, and then the lengths δs of the arch axis for each equal division of the span determined.

Let $\Delta = \delta s \div I$, then if H_1 represents the horizontal thrust at the supports, for vertical loads

$$2\,H_1 = \frac{\Sigma\, m_x\, \Delta\left(y - \frac{\Sigma y\,\Delta}{\Sigma\,\Delta}\right)}{\Sigma\, y\,\Delta\left(y - \frac{\Sigma y\,\Delta}{\Sigma\,\Delta}\right)} = \frac{\Sigma\, m_x\, B}{D} \qquad \text{.....(A)}$$

in which m_x is the common moment for the given loading plus an equal and symmetrically placed load on a beam supported at the ends.

In a previous* article it was shown for two arch rings having spans of L and 40 and rises of f and 1 respectively, that, when the ordinates $y_1 : y_2 : y_3 : y_4 : y_5 : \ldots - f = y_1' : y_2' : y_3' \ldots - (f' = \text{unity})$ and $\Delta_1 : \Delta_2 : \Delta_3 : \ldots - \Delta_{10} = \Delta_1' : \Delta_2' : \Delta_3' \ldots - (\Delta_{10}' = \text{unity})$

$$H_1 : H_1' = \frac{L}{40\,f} : 1 \text{ or } H_1 = \frac{L}{40\,f}\, H_1'$$

Now if n = 20, and $\delta x = L \div 20$, then $\frac{L}{40} = \frac{\delta x}{2}$ and $H_1 = \frac{\delta x}{2\,f}\, H_1'$

also $H_1 = \frac{2\,f}{\delta x}\, H_1$.

Supposing that formula (A) has been solved for a unit load at each point of division respectively, then the values of H_1' for each load are readily found by simple multiplication. In a like manner the expressions for the moments at the supports become $M_1 = \frac{\delta x}{2}\, M_1'$ and $M_2' = \frac{\delta x}{2}\, M_2'$. The vertical reactions remain the same regardless of changes in L and f.

Table A contains a complete set of coefficients which were based upon an arch having a span of 100 ft. and a rise of 16.67 ft. The depth of the ring at the crown and the springing being in the ratio of about 1 to 2.

Columns 1 and 2 of Table A contain the coefficients which must be satisfied by each arch ring to which the coefficients in the remaining columns apply. That is, each y for the axis must bear the ratio to the rise f of the axis as the coefficient in column 1 bears to unity, and each value of $\Delta = \delta s \div I$ must bear the relation to Δ_{10} that the coefficient in column 2 bears to unity. The use of the coefficients in Table A will become evident in the solution of a problem.

Assume that for some reason that the rise must be changed from 16.67 ft. to 12.5 ft. while the span remains unchanged or 100 ft.

In Table B, column 1 gives the new values of $y = 12.5\ y'$. In Fig. 1 divide the span into 20 equal parts and, at the centers of these divisions, lay off the ordinates y and draw a curve through

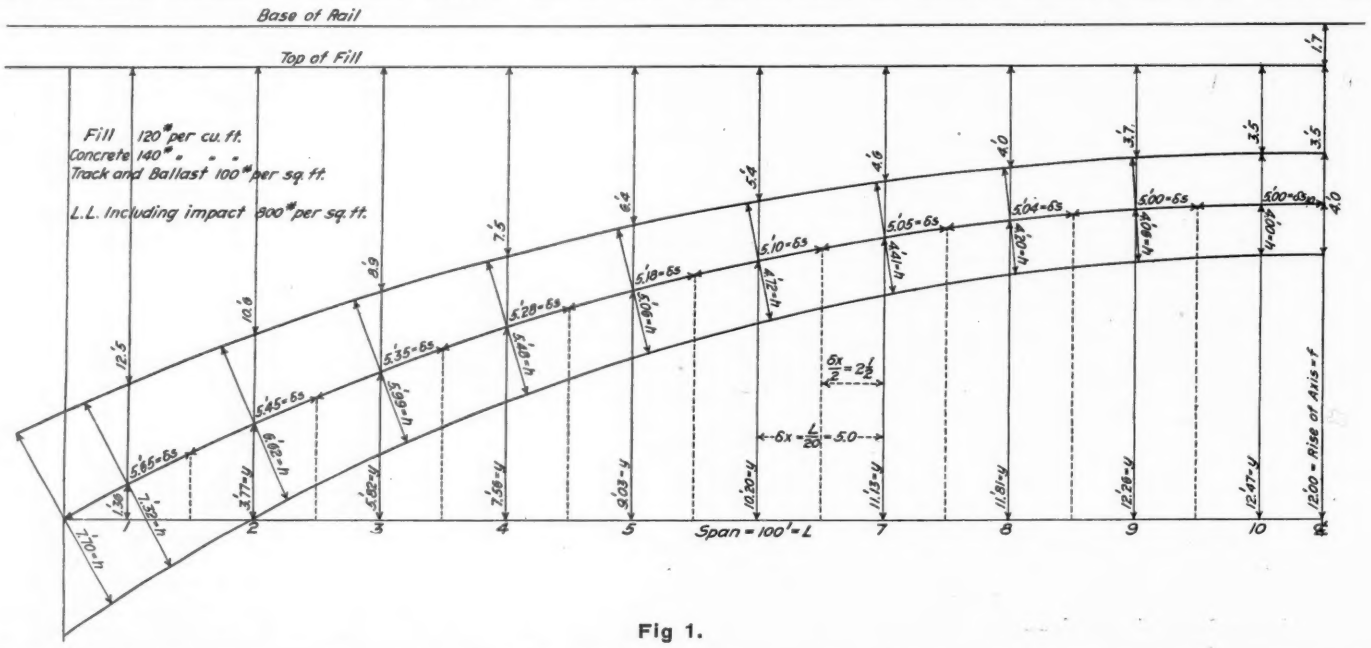

Base of Rail
Top of Fill
Fill 120# per cu. ft.
Concrete 140# " " "
Track and Ballast 100# per sq. ft.
L.L. Including impact 800# per sq. ft.
Span = 100' = L
1200 = Rise of Axis = f

Fig 1.

the extremities. This will be the new arch axis. Then scale the values of δs and place the results in column 2 of Table B.

The next step will be the assumption of the depth of the arch ring at the crown, or for all practical purposes at the section numbered 10. This depth will depend upon the loading and the material composing the ring as well as the radius of curvature at the crown. Let it be assumed that the ring is to be composed of concrete and that the fill will be composed of gravel and about 3 ft. deep over the crown. The moving load will be assumed at 5,000 lbs. per foot of span with 100 per cent. impact. In other words, a single-track railroad bridge is the structure to be designed. The depth at the crown by various empirical formulas will be somewhere in the vicinity of 4 ft., and, as a little error now can be easily corrected later, the depth will be assumed as 4 ft. at the section numbered 10. A longitudinal slice of the bridge 1 ft. thick is assumed. Then $I_{10} =$

*Railroad Gazette, Aug. 20, 1907.

5.333 and $\Delta_{10} = \delta s_{10} \div I_{10} = 5.00 \div 5.33 = 0.938$, and hence $\Delta_n = 0.938\ \Delta_n'$. These values are given in column 3 of Table B.

Since $\Delta = \frac{\delta s}{I}$, $I = \frac{\delta s}{\Delta} = \frac{h^3}{12}$ $\therefore$ $h = \sqrt[3]{\frac{12\delta s}{\Delta}}$ for each point.

The values of h are given in column 4 of Table B.

Assuming that the fill weighs 120 lbs. per cubic foot, the rails, ties and ballast to be equivalent to 100 lbs. per square foot, and that the concrete in the ring weighs 140 lbs. per cubic foot, the dead load concentrated at each point becomes as shown in column 5 of Table B. The dimensions employed are shown in Fig. 1. In column 6 of Table B are given the values of H_1 for unit loads at points 1, 2, 3, etc., respectively. These coefficients multiplied by the actual loads at these points will give the values of H_1 as shown in column 7 of Table B. The values of H_1 for the loads 1 to 10 is 62,230 lbs. and for the entire dead load this becomes $2 \times 62,230 = 124,500$ lbs. The vertical reactions V_1 and V_2 each equal one-half the entire dead load, or 79,500 lbs.

The computation of M_1 now follows: Since the coefficients M_1' are each multiplied by $\frac{\delta x}{2} = 2.5$ to obtain the values of M_1 for unit loads, this may be considered as a constant factor and introduced at the end of the calculation. In column 8 of Table B are given the sums of each pair of symmetrical values of H_1' as given in columns 5 and 6 of Table A. These multiplied by the dead load (column 9, Table B), and the sum multiplied by $\frac{\delta x}{2} = 2.5$ gives the value of M_1 and M_2 for the total dead load, or $M_1 = M_2 = -27,359 \times 2.5 = -68,400$ lbs. feet.

The equilibrium polygon is now located since $\frac{M_1}{H_1} = y_1 = -0.55$ ft., or the polygon starts 0.55 ft. below the axis at the support. For convenience in drawing the equilibrium polygon, the moment at crown should be computed by the formula,

$$M_x = M_1 + V_1 x - H_1 y - \Sigma^x P\,(x - a)$$
$$\text{or } M_c = M_1 + \tfrac{1}{2} L V_1 - H_1 f - \Sigma^{\frac{1}{2}L} P\,(\tfrac{1}{2}L - a)$$

In this case $M_c = -13,900$ and $y_c = \frac{-13,900}{124,500} = -0.11$ ft., or the polygon passes the crown 0.11 ft. below the axis. This polygon is shown on Fig. 2, one-half only being drawn as it is symmetrical. For convenience and accuracy in drawing the polygon, start at the support and at the crown and close at the quarter point.

Inspection shows that this polygon lies well within the middle third of the ring and that the maximum compression is very much below the safe strength of the concrete.

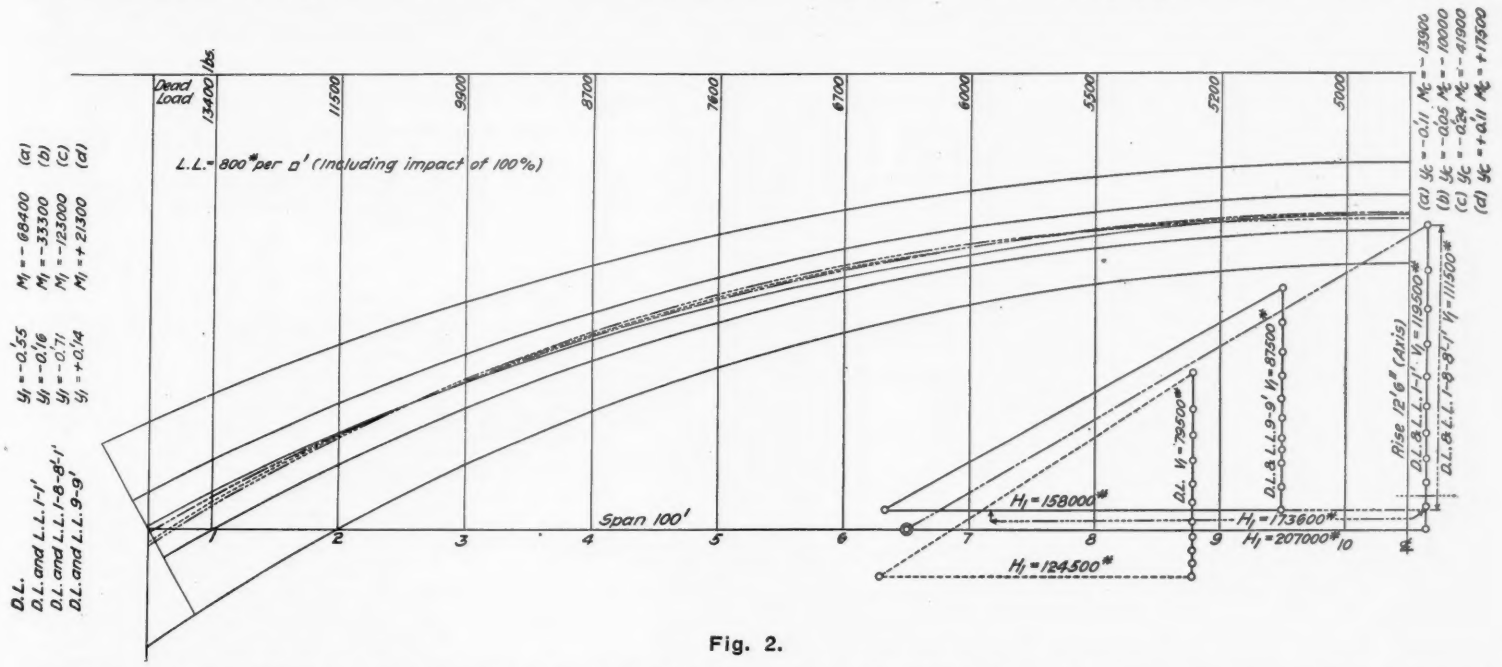


Fig. 2.

The live load will now be considered. Let this be 800 lbs. per square foot or $5 \times 800 = 4,000$ lbs. per division.

Table A, column 11, shows the fields of loading which produce maximum moments. (Approx.)

Live Load 1 to 8.

$H_1 = \frac{L}{40f} H_1' = 0.2\ H_1'$ or $H_1 = 0.2 \times 30,668 \times 4,000 = 24,500$ lbs.

$M_1 = \frac{\delta x}{2}\ M_1' = 2.5\ M_1'$ or $M_1 = -18.819 \times 2.5 \times 4,000 = -188,200$ lbs.-ft.

$V_1 = 7.203 \times 4,000 = 28,800$ lbs.

$V_2 = 32,000 - 28,800 = 3,200$ lbs.

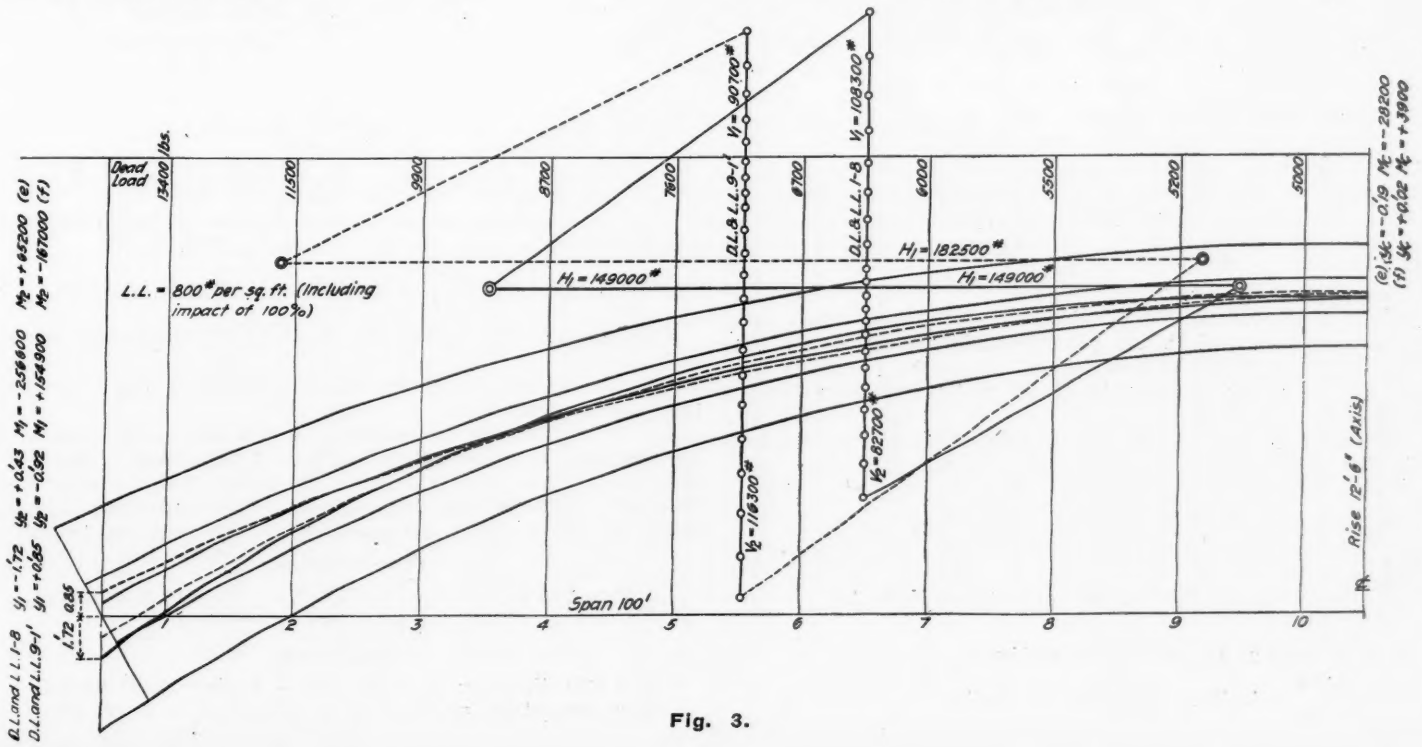


Fig. 3.

$M_2 = + 13.360 \times 2.5 \times 4,000 = + 133,600$ lbs.-ft.
$M_c = - 14,300$ lbs.-ft.

Combining these values with those obtained for the dead load the following results obtain:

Dead Load and Live Load 1 to 8.

M_1	D. L.	— 68,400 lbs.-ft.	M_2	D. L.	— 68,400 lbs.-ft.
	L. L.	—188,200 "		L. L.	+ 133,600 "
	D. L. + L. L.	—256,600 lbs.-ft.		D. L. + L. L.	+ 65,200 lbs.-ft.
H_1	D. L.	124,500 lbs.-ft.	M_c	D. L.	— 13,900 lbs.-ft.
	L. L.	24,500 "		L. L.	— 14,200 "
	D. L. + L. L.	149,000 lbs.-ft.		D. L. + L. L.	— 28,200 lbs.-ft.
V_1	D. L.	79,500 lbs.-ft.	V_2	D. L.	79,500 lbs.-ft
	L. L.	28,800 "		L. L.	3,200 "
	D. L. + L. L.	108,300 lbs.-ft.		D. L. + L. L.	82,700 lbs.-ft.

$$y_1 = \frac{-256,600}{149,000} = -1.72 \text{ ft.} \qquad y_c = \frac{-28,200}{149,000} = -0.19 \text{ ft.}$$

$$y_2 = \frac{+ 65,000}{149,000} = + 0.43 \text{ ft.}$$

In like manner each set of loadings is considered. Any other field can be taken by simply adding the values of H_1', M_1', V_1, etc., in Table A corresponding to the loading used.

The moment at the support is

$$M_1 = H_a \frac{\Sigma y \Delta}{\Sigma \Delta} = H_a Y' f = 0.817\ (12.5)\ H_a = (10.21)\ H_a \text{ (see Table A).}$$

By a brief calculation it becomes evident that the concrete will be subjected to tensile stresses greater than its safe strength when the axial thrust is considered without taking into account the effect of a drop in temperature, hence it becomes necessary to either reinforce the rib with steel or increase its depth. Assuming that the latter is not feasible the rib will be reinforced with steel.

Let $E_c = 1,500,000$ lbs. per square inch, and $E_s = 30,000,000$ lbs. per square inch, then $\frac{E_s}{E_c} = 20$ and each square inch of steel is equivalent to 20 square inches of concrete.

Let 1 per cent. of the area at the crown be assumed as steel, or 0.8 of a square foot of equivalent concrete, and place the center of the steel 0.25 ft. from the outside of the concrete. The effective area is now 4.0 + 0.8 = 4.8 sq. ft. = F at the crown, and practically at section number 10.

I = the moment of inertia = 7.78 and the section modulus S = 3.89.

Since the values of Δ must always remain in the relative magnitudes shown in column 2 of Table A, if the moment of inertia is

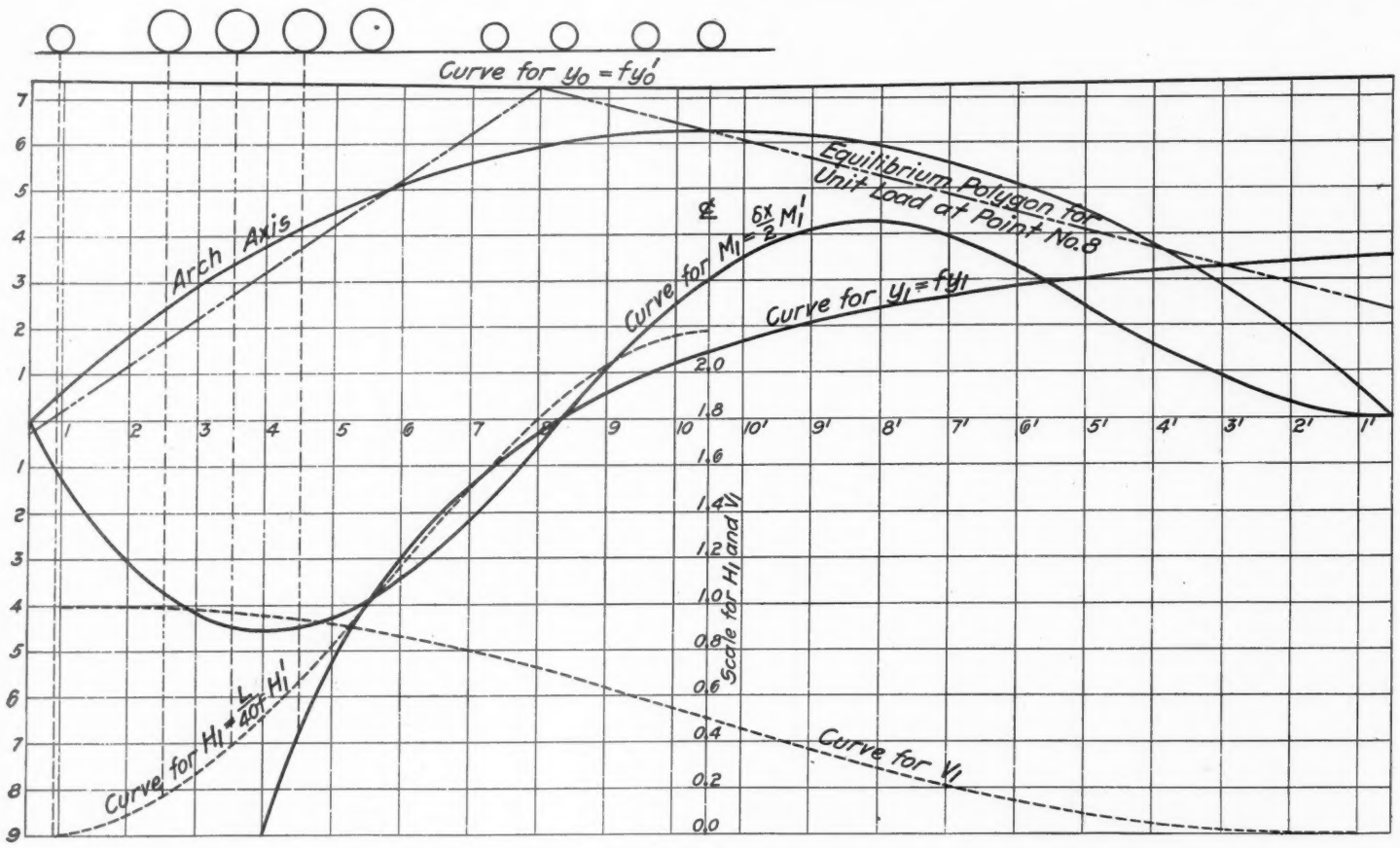

Curve for $y_0 = fy_0'$
Arch Axis
Equilibrium Polygon for Unit Load at Point No. 8
Curve for $M_1 = \frac{\delta x M_1'}{2}$
Curve for $y_1 = fy_1$
Curve for $H_1 = \frac{L}{40} H_1'$
Curve for V_1
Scale for H_1 and V_1

Fig. 4.

In Table C are given the values of H_1, M_1, etc., for the various loadings considered. Since the first four sets are symmetrical, only one-half of each equilibrium polygon is drawn, as shown in Fig. 1. In the last two sets the loading is not symmetrical and hence the polygons must be constructed for the entire span. Proceed as follows: Lay off y_1 and y_2 at the left support and y_c at the crown and construct both halves of the polygon on the left of the crown as shown in Fig. 3.

All of the above results are obtained with comparatively little labor and in a short time. As usually considered the arch rib, as shown in Fig. 1, would be passed as quite safe for the given loadings. But the effect of the axial thrust and temperature changes remain to be considered.

The effect of the axial thrust will be first taken up. The horizontal thrust is

$$H_a = H_1 \left\{ 1 - \frac{D}{D + \Sigma \frac{(\delta x)^2}{\delta s\, F}} \right\}$$

where

$D = D' f^2 \Delta_{10} = 0.589\ f^2 \Delta_{10}$ or $D = 86.32$ (see Table A)
$\delta x = 5.0$ ft.
F = area of rib at section considered.
$\Sigma \frac{(\delta x)^2}{F\, \delta s} = 19.43$ $\therefore$ $H_a = 18\%\ H_1$ (nearly)

increased at any section, the moment of inertia at each other section must be increased in like proportion.

At the crown the original I was 5.33 and 7.78 ÷ 5.33 = 1.46, or each section must have its I increased 46 per cent.

For example take section number 1. The original I was 32.68, and adding 46 per cent. to this I becomes 47.72, then

$$\frac{h^3}{12} + 0.8 \left(\frac{h - 0.5}{2} \right)^2 = 47.72 \text{ or } h = 7.65 \text{ ft. (nearly).}$$

The effective area is 7.65 + 0.80 = 8.45 and the section modulus is 12.42.

In like manner the proper depths of the arch ring at other sections can be determined.

It is not feasible or necessary in this article to compute the fiber stresses for all loads at all points. The method is identical in each case so one example only will be given. Point number 1 will be selected and the fiber stress for the dead load, dead load axial thrust and a change of temperature of ± 20 deg. be determined.

Point Number 1.

F = 8.45 sq. ft.	S = 12.42.	Sin Φ = 0.454.
Cos Φ = 0.885.	y = 1.36 ft.	x = 2.5 ft.

Dead Load.

The axial thrust = $N_x = H_1 \cos \Phi + V_1 \sin \Phi = 146,300$ lbs.
The moment $M_x = M_1 + V_1 x - H_1 y = - 39,200$ lbs.-ft.

The fiber stress $p = \frac{N_x}{F} \pm \frac{M_x}{S} = \frac{146,300}{8.45} \pm \frac{-39.200}{12.42}$

Or the stress in the upper fiber = + 14,100 lbs.,
and the stress in the lower fiber = + 20,500 lbs.

Dead Load Axial Thrust.

Assume H_a = 1,000 lbs. and determine the fiber stresses. $N_x = 1,000\ (0.885) = 885$ lbs. $M_x = 1,000\ (10.21 - 1.36) = 8,860$ lbs.-ft.

$$p = \frac{-885}{8.45} \mp \frac{8860}{12.42}$$

Or, the stress in the upper fiber = — 818 lbs.,
and the stress in the lower fiber = + 609 lbs.

Then for H_a = 1 lb., these quantities become — 0.818 lbs. and + 0.609 lbs. respectively.

For the dead load H_a = 18 per cent. H_1 = 18 per cent. 124,500 = 22,400 lbs.

Therefore, the stress in the upper fiber = 22,400 × 0.818 = — 18,300 lbs., and the stress in the lower fiber = 22,400 × 0.609 = + 13,600 lbs.

Temperature change of ± 20°:

$$H_t = \frac{e\,t°\,E\,L}{0,589\ f^2\ \Delta_{10}} = \frac{e\,t°\,E\,L}{86.32}$$

e = 0.000006.
E = 1,500,000 × 144 per sq. ft.
L = 100 ft.
t° = 20°.

and H_t = 30,000 lbs.

Reducing this for the effect of the axial thrust
H = 82 per cent. 30,000 = 24,600 lbs.

The stress in the upper fiber = 24,600 × 0.818 = ± 20,100 lbs., and in the lower fiber 24,600 × 0.609 = ∓ 15,000 lbs.

In precisely the same manner any other loading can be considered or any other section of the arch ring examined.

Table D contains the fiber stresses for section number 1 and at the crown for various loadings. Exclusive of the temperature effect the maximum tension in the concrete is 12,700 lbs. per square foot, or a little less than 100 lbs. per square inch. The maximum compression is at point 1 and equals 52,800 lbs. per square foot, or about 370 lbs. per square inch. The stress in the steel is less than 20 × 370 = 7,400 lbs. per square inch.

If the temperature effect is considered, the maximum tension in the concrete is 38,500 lbs. per square foot, or about 270 lbs. per square inch, and in the steel less than 20 × 270 = 5,400 lbs. per square inch. The maximum compression, including the effect of temperature, is 67,800 lbs. per square foot, or about 470 lbs. per square inch, and in the steel, less than 20 × 470 = 9,400 lbs. per square inch.

In case the tension values are considered too large the arch ring can be made a little deeper.

The dead load was based upon a plain concrete ring which now has been increased in depth a maximum amount at the supports and not at all at the crown. At section number 1 the additional concrete increases the dead load about 150 lbs., which is of no practical importance when it is considered that the dead load assumed for this section was 13,400 lbs. Increasing the depth of the ring actually decreases the effect of the axial thrust and hence the values given in Table D are a little large. Since the stresses due to temperature changes include the axial thrust effect, the values given in Table D are a little small.

The above solution shows that the use of unit loads in determining the values of H_1, M_1, V_1, etc., for an arch ring, enables the designer to change at will the loads, the span and the rise of the arch as well as the depth of the ring with very little labor.

Although the loads have been assumed as concentrated at the points of division as being most convenient for determining H_1, M_1, V_1, etc., for unit loads, it is not at all necessary that the actual loading should be so arranged. The actual loading may be placed anywhere and the unit values of H_1, M_1, V_1, etc., are determined from a curve drawn with the computed values of these quantities based on unit loads placed at the points of division. (See Fig. 4.)

That the summation method is approximate must be conceded by all, but it can be made a very close approximation. The largest errors in the values of H_1 lie near the supports where the actual values are small. For a parabolic arch computed by the integration method and the summation method the difference in the values of H_1 was 0.16 per cent. By the integration method the values of M_1 were — 63.004 and + 62.936, and by the summation method — 62.510 and 61.940.

TABLE B.

Point No.	1. $y = f\,y'$ or $12.5\,y'$ ft.	2. δs Scaled from Fig. 1. ft.	3. $\Delta = \Delta'\,\Delta_{10}$ or $0.938\,\Delta'$	4. $h = \sqrt[3]{\frac{12\,\delta s}{\Delta}}$ ft.	5. D L Dead Load W lbs.	6. H_1 or $\frac{L}{40f}\,H'$ or $0.2\,H'$ unit lds.	7. $W H_1$	8. Symmetrical values of M_1' combined M'	9. W M
1.	1.36	5.65	0.173	7.32	13,400	0.0000	0,000	1,000	—13,400
2.	3.77	5.45	0.225	6.62	11,500	0.0886	1,019	2,214	—25,461
3.	5.82	5.35	0.298	5.99	9,900	0.2610	2,584	2.660	—26,334
4.	7.56	5.28	0.384	5.48	8,700	0.5094	4,432	2.378	—20,689
5.	9.03	5.18	0.480	5.06	7,600	0.8170	6,209	1.473	—11,195
6.	10.20	5.10	0.588	4.72	6,700	1.1574	7,755	0.127	— 851
7.	11.13	5.05	0.709	4.41	6,000	1.4982	8,989	1.436	8,616
8.	11.81	5.04	0.819	4.20	5,500	1.8020	9,911	2.956	16,258
9.	12.26	5.00	0.899	4.06	5,200	2.0304	10,558	4.158	21,622
10.	12.47	5.00	0.938	4.00	5,000	2.1526	10,763	4.815	24,075
							62,230		—97,930
									+ 70,571
									—27,359

TABLE C.

1.	(a)	(b)	(c)	(d)	(e)	(f)
Loading.	D. L.	D.L. and L.L., 1-1′.	D.L. and L.L. 1-8 & 8′-1′.	D.L. and L. L. 9-9′.	D.L. and L. L. 1-8.	D.L. and L.L. 9-1′
2. M_1	— 68,400	— 33,300	—122,990	+ 21,300	—256,600	+ 154,900
3. M_2	— 68,400	— 33,300	—122,990	+ 21,300	+ 65,200	—167,000
4. H_1	124,500	207,000	173,600	158,000	149,000	182,500
5. V_1	79,500	119,500	111,500	87,500	108,300	90,700
6. V_2	79,500	119,500	111,500	87,500	82,700	116,300
7. M_c	— 13,900	— 10,000	— 41,900	+ 17,500	+ 28,200	+ 3,900
8. y_1	—0.55	—0.16	—0.71	+ 0.14	—1.72	+ 0.85
9. y_c	—0.11	—0.05	—0.24	+ 0.11	—0.19	+ 0.02
10. y_2	—0.55	—0.16	—0.71	+ 0.14	+ 0.43	—0.92

TABLE D.

1. Loading.	2. Point No. 1 Top fiber.	3. Point No. 1 Bottom fiber	4. Loading.	5. Crown Top fiber.	6. Crown Bottom fiber
D. L.	+ 14,100	+ 29,400	D. L.	+ 22,400	+ 29,600
D. L. axial	—18,300	+ 22,700	Axial	+ 8,400	—17,800
Sum	— 4,200	+ 34,100	Sum	+ 30,800	+ 11,800
Temp. ± 20°	± 20,100	∓ 15,000	Temp. ± 20°	∓ 9,300	± 19,600
Total	—24,300	+ 49,100	Total	+ 40,100	— 7,800
D.L. & L.L. 1-8.	+ 6,200	+ 36,600	D.L.& 1-8 & 8-1′	+ 25,300	+ 47,100
Do., axial	—21,900	+ 16,200	Axial	+ 11,800	—24,800
Sum	—15,700	+ 52,800	Sum	+ 37,100	+ 22,300
Temp. ± 20°	± 20,100	∓ 15,000	Temp. ± 20°	∓ 9,300	± 19,600
Total	—38,500	+ 67,800	Total	+ 46,400	+ 41,900
D.L. & 1-1′	+ 26,800	+ 29,400	D. L. & 9-9′	+ 37,500	+ 28,500
Axial	—20,500	+ 22,700	Axial	+ 10,700	—22,600
Sum.	— 3,700	+ 52,100	Sum	+ 48,200	+ 5,900
Temp. ± 20°	± 20,100	∓ 15,000	Temp. ± 20°	∓ 9,300	± 19,600
Total	—23,800	+ 67,100	Total	+ 57,500	—13,700

NOTE.—All stresses are expressed in pounds per square foot. The + sign signifies compression.

TABLE A.

Point No.	1. $y = f\,y'$ y'	2. $\Delta = \Delta_{10}\,\Delta'$ Δ'	3. $H_1 = \frac{L}{40\,f}\,H_1'$ H'	4. $M_1 = \frac{\delta x}{2}\,M_1'$ M_1'	5. $M_2 = \frac{\delta x}{2}\,M_2'$ M_2'	6. $V_1 = V_1$ V_1	7. $V_2 = V_2$ V_2	8. $y_1 = f\,y_1'$ y_1'	9. $y_2 = f\,y_2'$ y_2'	10. $y_0 = f\,y_0'$ y_0'	11. Points loaded (inclusive).	12. $H_1 = \frac{L}{40\,f}\,H_1'$ H_1'	13. $M_1' = \frac{\delta x}{2}\,M_1'$ M_1'	14. $M_2 = \frac{\delta x}{2}\,M_2'$ M_2'	15. $V_1 = V_1$ V_1
1.	0.1086	0.1840	0.000	—1.000	0.000	1.000	0.000	.....	.....	.....	.....	.....	.....	.....	.....
2.	0.3012	0.2395	0.443	—2.455	0.241	0.992	0.008	—5.967	0.538	1,186	1-8	30.668	—18.819	+13.360	7.203
3.	0.4656	0.3180	1.305	—3.347	0.687	0.976	0.024	—2.719	0.522	1.178	9-1′	72.498	+22.333	— 9.846	2.797
4.	0.6048	0.4087	2.547	—3.667	1.289	0.949	0.051	—1.530	0.502	1.168	1-8 and 8′-1′	61.336	— 5.459	— 5.459	8.000
5.	0.7224	0.5115	4.085	—3.443	1.970	0.910	0.090	—0.902	0.479	1.161	9-9′	41.830	+ 8.973	+ 8.973	2.000
6.	0.8160	0.6266	5.787	—2.752	2.625	0.859	0.141	—0.513	0.451	1.157	1-1′	103,166	+ 3.514	+ 3.514	10.000
7.	0.8892	0.7564	7.491	—1.706	3.142	0.796	0.204	—0.251	0.418	1,151	1-10	51.583	—16.002	+19.516	8.386
8.	0.9444	0.8728	9.010	—0.450	3.406	0.721	0.279	—0.066	0.376	1.147	....	.....	.....	.....	.....
9.	0.9804	0.9580	10.152	0.838	3.320	0.637	0.363	0.072	0.324	1.146	....	.....	.....	.....	.....
10.	0.9972	1.0000	10.763	1.979	2.836	0.546	0.454	0.177	0.259	1.144	....	.....	.....	.....	.....
	.....	.....	51.583	....	.....	.....	.....	.....	.....	.....	Each point with load, P = 1.				

D′ = 0.5890. Y′ = 0.817.

Rebuilding the Northern Pacific in Minnesota.

BY H. COLE ESTEP.

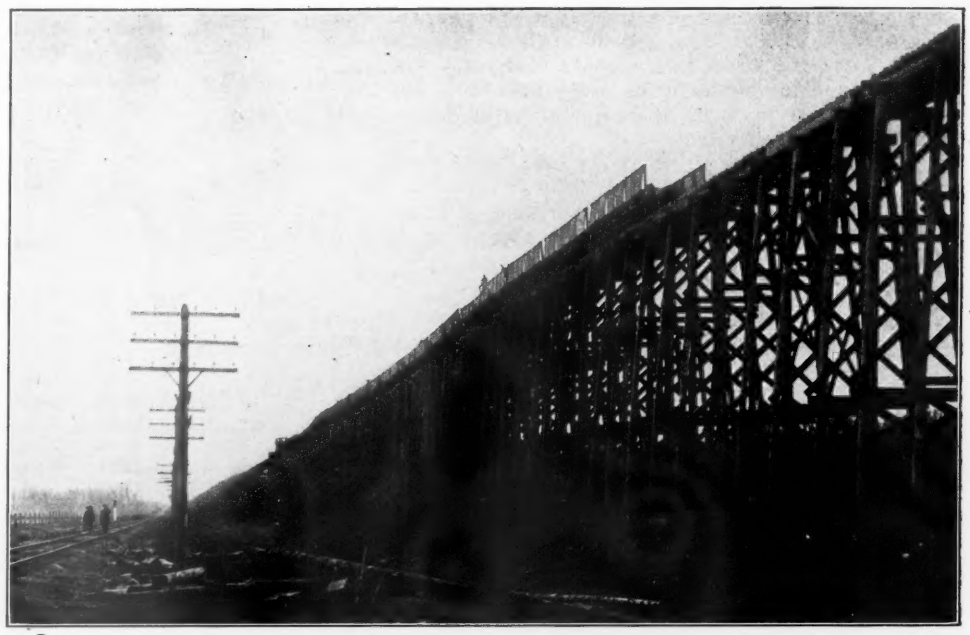
From Staples, Minn., to Fargo, N. Dak., a distance of 109 miles, the Northern Pacific is now engaged in one of the most important and interesting pieces of reconstruction work on the entire main line between St. Paul and Portland. This Minnesota work is distinguished both for its quantity and quality. It is the largest single continuous betterment now under way on the Northern Pacific system, and is at the same time the most thorough and complete. While the engineering problems encountered lack some of the spectacular features of mountain work, they are much more difficult and interesting by virtue of their very subtlety.

The improvements include double tracking, reballasting, reduction of grades and modifications of alinement throughout the whole of the 109 miles from Staples to Fargo. Some of the simple double-tracking and reballasting was done in 1903 and 1904. The heavier reconstruction work between Wadena and Glyndon was commenced during the spring of 1906. All of that between Wadena and Lake Park, 54.1 miles, is now practically completed; about one-fifth of the work on the 25 miles from Lake Park, Minn., west to Glyndon, remains to be finished this spring.

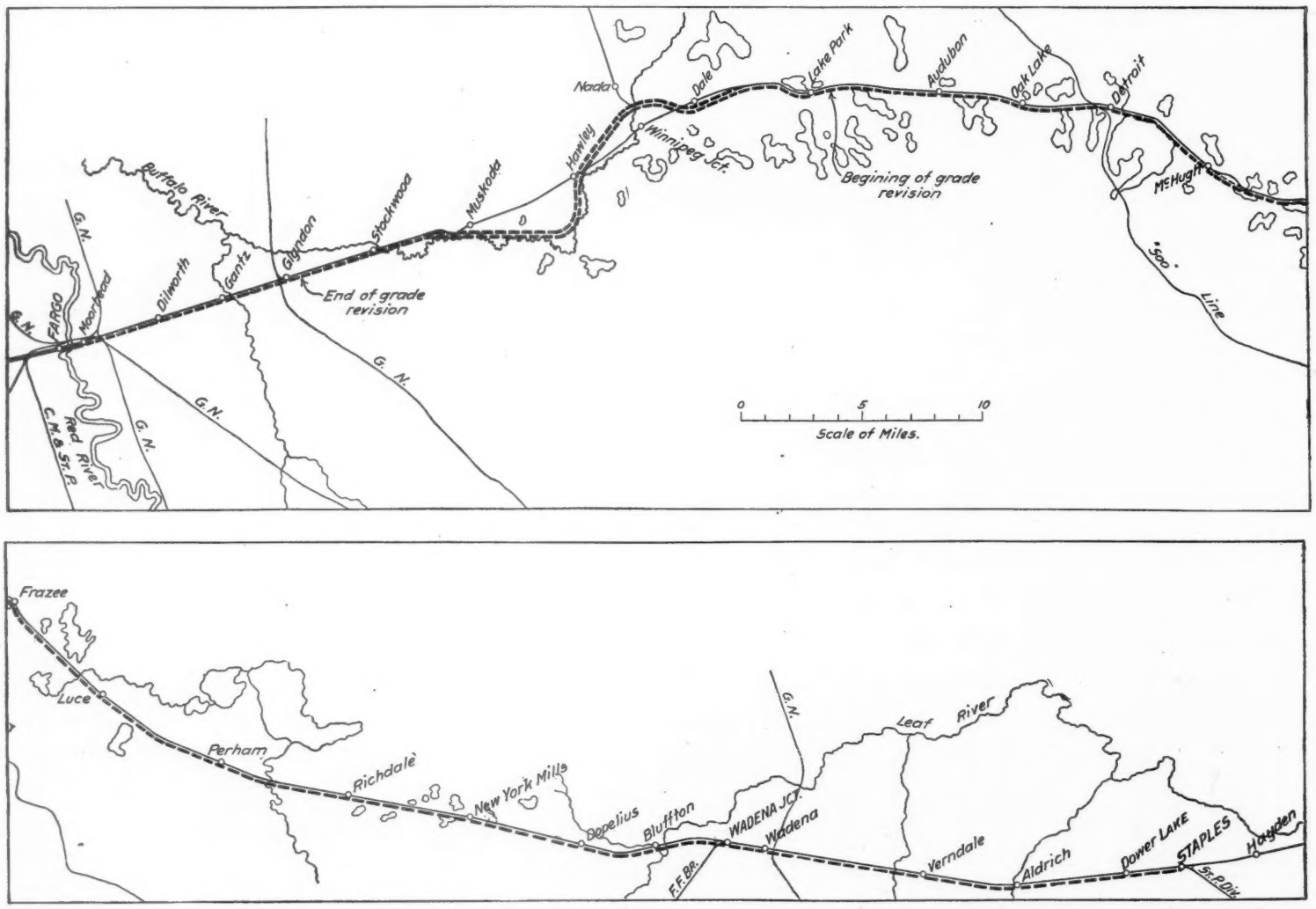
At Staples the main line from Duluth joins the line from St. Paul and Minneapolis. As a result this division between Staples and Fargo bears the densest traffic of any similar stretch on the Northern Pacific system. It not only carries the normally heavy main line freight and passenger travel, but in addition, every autumn must take care of all the eastbound grain and live stock coming from Montana and North Dakota, as well as the westbound coal and supplies going into the same district. Between Lake Park and Hawley on the old line there was a heavy pusher grade against both east and westbound traffic. It was to relieve the pressure on the single track due to the unusually dense traffic over this division and to eliminate the expensive, time-wasting pusher service between Lake Park and Hawley that the present improvements were undertaken.

The work falls naturally into five sections, as follows: From Staples west to Dower Lake, 2.8 miles; from Dower Lake to Wadena, 14.5 miles; from Wadena to Lake Park, 54.1 miles; from Lake Park to Glyndon, 27.6 miles, and from Glyndon to Fargo, 9.9 miles.

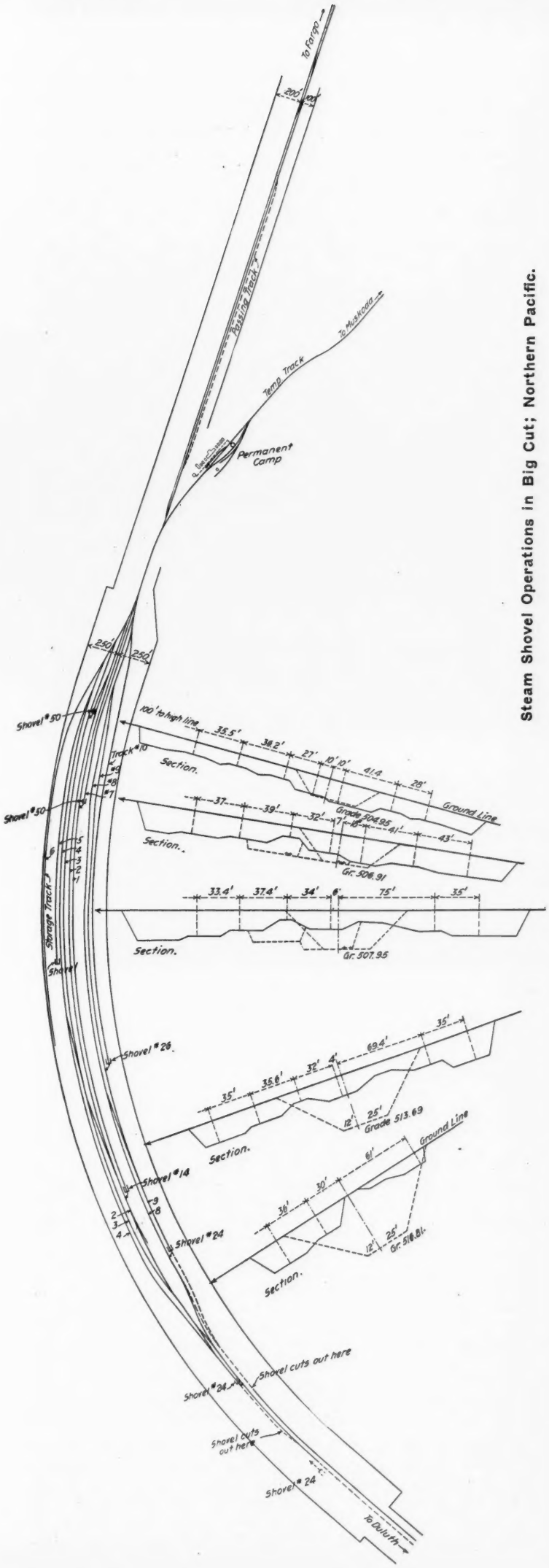
In 1903 the first section, 2.8 miles between Staples and Dower Lake, was double-tracked and reballasted without change of grade or alinement. Similar improvements were made on the second section, 14.5 miles between Dower Lake and Wadena, in 1904.



View Showing Fill, Temporary Trestle, and Old Main Line.



General Location; Northern Pacific Grade Revision and Second Track Work.



Steam Shovel Operations in Big Cut; Northern Pacific.

The third section, 54.1 miles between Wadena and Lake Park, contains aside from the usual double-tracking and reballasting, grade revisions of importance and one notable line change. Before the improvements on this section were made there was a 0.4 per cent. virtual grade east and westbound. This has been lowered to 0.3 per cent. actual east and westbound; the total rise and fall has been reduced 176 ft., while the total curvature has been cut down 130 deg.; 1,800,000 cu. yds. of material were required for the improvements. The work was commenced in April, 1906, was suspended during the winter of 1906-07, resumed in the spring of 1907, and is now practically finished.

The one line change occurs near McHugh, Minn., 40 miles west of Wadena. It is one mile in length. As is seen from the accompanying map, the old line was carried northward following the arc of a circle around the contour of the hills, and thus avoiding the heavy cut and fill necessary on the new location, which goes directly across the hills. The new line contains a 2,000-ft. fill averaging 50 ft. in height, and a cut 2,500 ft. long, approximately 30 ft. deep. By virtue of this line change a heavy grade is reduced, the main line is shortened and the soft, uncertain foundation upon which the old grade was built is replaced by firm, unyielding construction.

The fact that in a thorough revision of the 54.1 miles comprising this section of the work only one line change was required to bring the new double-track road fully up to the requirements of today is highly complimentary to the ability and foresight of the engineers who originally located this division. It is not often that we find an old road so located as to combine the low first cost which was necessary in the first instance, with the possibility of economical revision to meet the requirements of later and more prosperous days. The task confronting the original locating engineers can be better appreciated when we consider the topography of the region through which the road is built. This territory—known as the lake park region of Minnesota—is strewn with innumerable sheets of water varying in size from mere ponds to lakes 15 or 20 miles in length. Separating these bodies of water are rolling hills from 20 to 100 ft. in height, while various chains of ponds and lakes are connected by creeks and small rivers.

We have here the old problem of choosing the best of the several possible routes which lie in a lightly rolling country, complicated by the presence of the lakes. The large ones must be skirted, while the small ponds are often too soft to fill economically. This results in a strong tendency to locate a very crooked line in order to avoid heavy and expensive cuts and fills. The original engineers, however, seeing into the future, located a comparatively straight line in spite of the lakes, and attained the requisite economy of construction by introducing rather heavy grades.

The problem of revising and modernizing this line was comparatively simple. All that was necessary was to cut down the humps and with the material so obtained fill in the sags. The economy of this is patent. Where a radical revision is necessary, interest must be paid on the cost of an entirely new road, including new right-of-way, and also on the cost of the old road and right-of-way which is abandoned. In this case the company had only to finance the cost of the second main track and of the work required to bring the old construction into line with present day requirements.

The fourth section of the work comprises 27.6 miles between Lake Park and Glyndon, Minn. Here we find the heaviest construction and most daring engineering of any piece of railroad in the state of Minnesota. For a prairie country, the new work on this 27.6 miles is in every sense spectacular.

At Winnipeg Junction, seven miles west of Lake Park, is the Buffalo river, which is the controlling feature of the situation. The old line, in order to cross this valley, contained grades of 0.9 per cent. against eastbound, and 0.75 per cent. against westbound traffic. Expensive pusher service had to be maintained between Stockwood and Hawley, 11 miles, in order to assist heavy freight trains over these hills. The exigencies of the situation demanded a complete relocation of this section, which resulted briefly as follows: Increase in distance, 2.3 miles; increase in total curvature, 120 degs.; reduction of east and westbound grades respectively to 0.3 and 0.01 per cent. The resultant reduction in operating expenses will fully justify the heavy expense incurred by this relocation.

To complete the improvement 5,850,000 cu. yds. of material, mostly earth, must be removed. Of this total, 4,750,000 yds. have been moved to date, leaving 1,100,000 yds. to future operations. The work was commenced in May, 1906, was suspended during the winter of 1906-07, resumed in March, 1907, and is again suspended on account of winter weather. West of Hawley, both the engineering and the construction work is being done by the railroad company.

The new line is a succession of heavy cuts and fills. Cuts from 1,800 to 2,500 ft. long, 35 to 40 ft. deep, and containing 150,000 to 280,000 cu. yds. alternate with fills of equal length, height and bulk. The channel of the Buffalo river has been changed and the river is now crossed on a pile trestle 45 ft. high. At several points the new line crosses over the old, which was kept open by timber bulkheads, a temporary pile bridge spanning the gap in the new embankment.

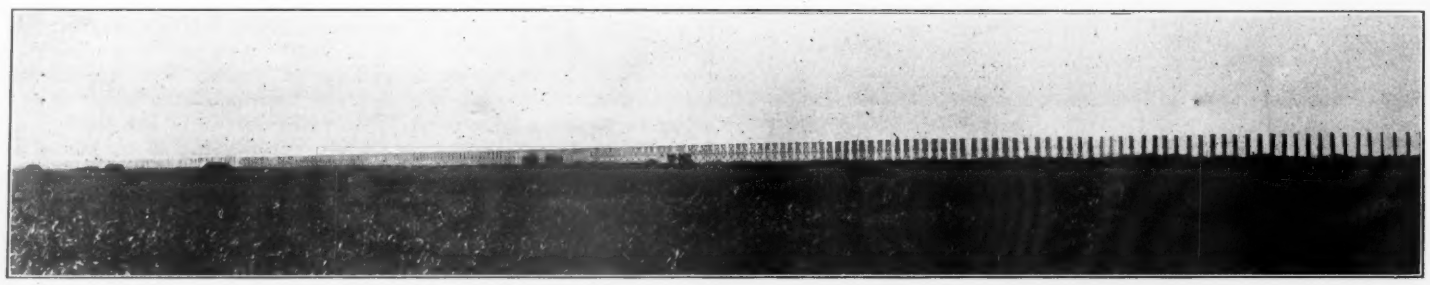
The largest cut on the work is located near mile post 238, be-

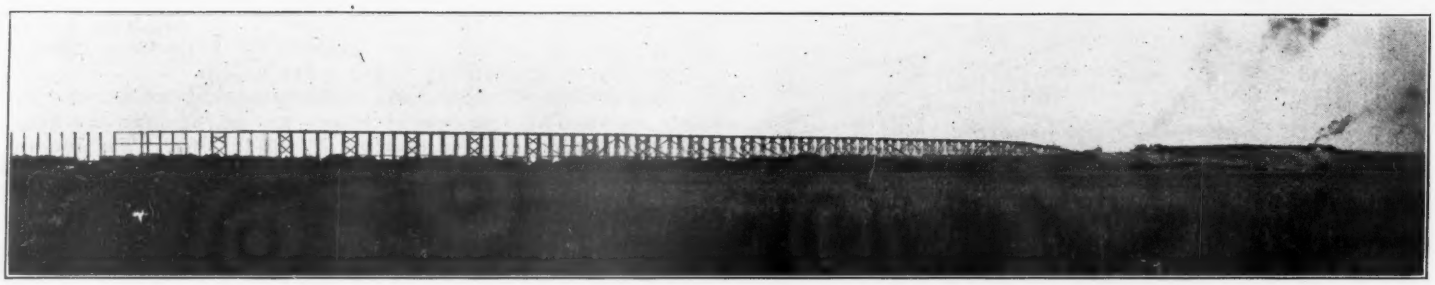
tween Muskoda and Hawley. It is 7,000 ft. long with an average depth of 45 ft. This cut is followed by a stupendous fill 50 ft. high at its maximum and 34,000 ft. long. The cut, which also served as a borrow pit, was excavated by steam shovels in standard American fashion. The accompanying plan and sections of this cut show the general scheme employed in operating the shovels. The extra wide section to which the cut was excavated was adopted so that there would be no snow blockades at this point, even in the worst Minnesota blizzards.

In making the big fill a pile trestle 25,000 ft. long, consisting of four pile bents spaced 15 ft. apart, was built. The material from the steam shovels in the cut was loaded on trains of flat cars, which were pushed out on the trestle and unloaded with a ballast plow. In this way very low unit costs were obtained. The culverts under the big fill are all of permanent construction, the larger ones being monolithic reinforced concrete arches.

From Glyndon to Fargo, the last section of the work under consideration, the improvements consisted simply in reballasting and laying the second track without change of grade or alinement. The work between Glyndon and Moorhead was finished in 1906, that between Moorhead and Fargo the year previous. The bridge across the Red river at this point is a single-track structure protected by automatic block signals.

It will not be amiss to emphasize again that the chief reason why this work has been carried out with economic success is that the division, taken as a whole, was so located originally that permanent and effective betterments could be made at a minimum of expense. To get a clear understanding of the matter the previous betterment work that has been done on this district should be known.





Temporary Trestle Nearly Five Miles Long; Northern Pacific Grade Revision.

Originally the road was built from Staples to Fargo with 1 per cent. ruling grades. In 1897, by an expenditure of $217,000, the district was so revised that the grades were reduced to 0.4 per cent. virtual, leaving, however, 20 miles of eastbound pusher grade near Hawley. At that time more expensive improvements were not economically advisable, but all of the work was done with a view to future permanent revision.

In 1906 traffic had grown to such large proportions that the construction of a second main track became an absolute necessity. This track could not be laid alongside the old one, but had to be properly and permanently located, fulfilling the demands of the present and anticipating those of the future. Ultimate economy was the aim.

The Northern Pacific is not only stronger financially by reason of this betterment, but is also owner of what is undoubtedly the finest stretch of railroad in the state of Minnesota. The new line, indeed, compares equally with the best modern construction on the trunk line systems of the east; a fact which is pregnantly suggestive of the true status of western ideals in railroad construction and of the firm, solid character of the prosperity of the great empire lying west and north of the Mississippi and Missouri valleys.

The construction work which was done directly by the company was carried out under the supervision of S. A. McCoy, Assistant Engineer. W. L. Darling, Chief Engineer, is responsible for the general design and execution of the entire project.

The writer wishes to acknowledge his indebtedness to the Northern Pacific Railway Company for the data, maps, etc., which accompany the article, and also to acknowledge the personal courtesy and assistance of Howard Elliott, President of the Northern Pacific, W. L. Darling, Chief Engineer, and S. A. Bratager, Principal Assistant Engineer.

The Proposed Elimination of Grade Crossings at Worcester, Mass.

BY CHARLES B. BREED,
Associate Mem. Am. Soc. C. E.

Although the state of Massachusetts was the first to undertake, in a systematic manner, the abolition of grade crossings, this has sometimes been accomplished with such deliberation that the progress of the work has not been as rapid in Massachusetts as in some other states. There has been more than one reason for delay in the advancement of this work in Massachusetts. In the first place, the grade crossing statute of 1890, together with its subsequent amendments, provides that the apportionment of cost shall be divided as follows: The steam railroad shall pay 65 per cent., the municipality not over 10 per cent., and the remainder shall be apportioned between the state and the street railway companies which may be operating in the streets where grade crossings occur, and which are benefited by their elimination. With this fixed apportionment of costs, it is evident that the interested parties, in their overzealousness for certain advantageous features of design or construction, may delay the settlement of the whole matter for an unreasonable length of time. Furthermore, it always takes considerable time to awaken public interest in these important matters, so that it frequently happens that the municipality does not realize what its needs and desires are until the hearings relative to the grade crossings have been well under way. The whole proceeding is one of education for the municipal authorities, who, as a rule, are dealing with this important problem for the first time. The railroads, on the other hand, are thoroughly familiar with such matters and frequently their preliminary studies of any particular situation have been made several years in advance of the city's designs.

The city of Worcester, in the early stages of the grade crossing discussions, furnished a good example of lack of preparation and familiarity with the problem. The earliest commission to consider the grade crossing problem in Worcester, appointed by the Superior Court in 1890, reported on the elimination of the crossing at Grafton street only, and recommended that the railroad should be elevated 2 ft. and the street depressed 13 ft. The city then appointed a commission of three civil engineers, including the city engineer, who, after making an exhaustive study of the problem, reported on five different methods of abolishing the crossings and recommended the adoption of a plan for elevating the railroad and depressing the streets a small amount. Later, a commission, composed of 12 citizens, considered the whole subject and reported favorably on track elevation. Several Acts, presented by the city of Worcester, passed the state legislature and delayed the settlement of these questions until finally, in 1900, another special grade crossing commission was appointed by the Superior Court under the statute of 1890. The report of this commission has recently been made a decree by the court. After nearly 17 years of study and discussion the matter has finally been decided and the work, which will be briefly described hereafter, will probably be started next spring.

The city of Worcester is located about in the middle of the state, where the topography is somewhat rolling. The northerly portion of the city is quite hilly, that district being given up almost entirely to residences. In the southerly and easterly portions are the railroads, located through rolling country, and adjacent to them are the manufacturing industries for which the city is noted.

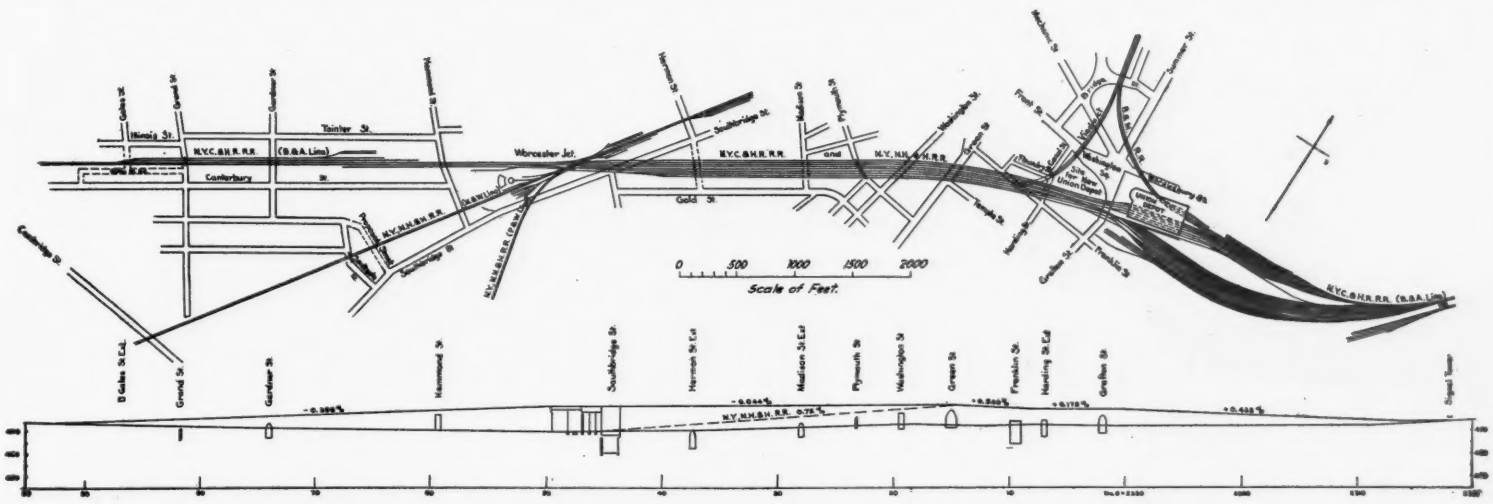
Referring to Fig. 1, it will be seen that the Boston & Albany division of the New York Central runs in a general east and west direction. At the present time the Norwich & Worcester and the Providence & Worcester divisions of the New York, New Haven & Hartford run along parallel to and on the south side of the Boston & Albany from Worcester Junction to the Union Depot, the passenger traffic running into the station on the south side of the Boston & Albany tracks. The freight traffic of the New Haven, however, crosses the Boston & Albany at grade at Worcester Junction to reach the New Haven freight house, which is located on the north side of the Boston & Albany. Furthermore, all interchange of freight between the New Haven and the Boston & Maine is made by crossing the Boston & Albany at grade near Franklin street and by passing over the short location, called the "Viaduct," which is used at the present time for freight traffic only. The Boston & Maine joins the Boston & Albany at the Union Passenger Station. Its passenger trains run into the Union Station, crossing Summer street and Shrewsbury street at grade, and its freight traffic goes over the Viaduct and connects with the Boston & Albany or crosses it at grade to reach the New Haven road. The work which is to be undertaken is the elimination of these two railroad grade crossings at Worcester Junction and at the connection with the Viaduct, and it is proposed to abolish all the highway grade crossings on the Boston & Albany and two on the Norwich & Worcester, but those on the Boston & Maine have been left for future independent consideration. The remaining street crossings on the New York, New Haven & Hartford within the city limits already pass either over or under the railroad. There are also no grade crossings on the Viaduct, this connection having been originally so built as to pass above the streets. The proposed work also involves building a new union passenger station and the necessary connections with the Haven tracks from the south side to the north side of the Boston & Albany road, the railroad grade crossing at the junction with the Viaduct is eliminated. On account of this feature it will be seen from the profile that it has been necessary to depress the Hermon street extension and Madison street extension considerably, so as to pass under the New Haven tracks.

From the Union Depot to Worcester Junction, two streets, Franklin and Southbridge, already pass under the railroad and the elevation of the tracks will evidently require no change in the grade of these streets. Grafton street will be depressed about 7 ft. and pass under the tracks, the railroad being supported on a masonry arch, the clear headroom above the street to be 16 ft.; this will be cut down slightly by trolley wire connections for electric car lines which occupy this thoroughfare. This arch is illustrated in Fig. 2.

To eliminate the grade crossings at Summer street and at Shrewsbury street, it was at first suggested that the passenger traffic of the Boston & Maine could be carried over the Viaduct and then switched back into the Union Depot. This objectionable feature of switching led to the suggestion that the new passenger station should be located between the Viaduct and Green street, but it was finally decided that the location, shown on Fig. 1, in the angle between the Viaduct and the Boston & Albany tracks would be serviceable for all three railroads.

The site for the new union passenger depot having been decided upon, it seemed advisable to continue Harding street, carrying it under the railroad so as to connect with Canal street, on the other side of the tracks. The railroad above this street is to be supported on a steel bridge with watertight floor and with provision for deadening the sound of passing trains.

Green street, a street of very heavy traffic, including two elec-



General Layout of Worcester Grade Revision, and Profile of Boston & Albany Entrance.

Boston & Albany freight yard, which is to remain undisturbed in grade.

On the Boston & Albany this work will involve the elevation of two and a half miles of the two-track main line, a mile and a half of which will be raised to an average height of about 17 ft. above the present grade, while the "run-offs" at each end of the track elevation will require the remaining mile. Fig. 1 shows the plan and profile of this location. It will be seen that the maximum grade on this elevated portion of the road will be 0.540 per cent. for westbound traffic, and 0.398 per cent. for eastbound. Worcester is a division point. The ruling grades on the division from Boston to Worcester are, both westbound and eastbound, 0.57 per cent. For the division from Worcester to Springfield they are for westbound 0.97 per cent., and for eastbound 0.99 per cent. It is obvious, then, that the proposed railroad grades are well within the required limits. Throughout this entire elevation the railroad is to be on an earth embankment with side slopes, except for occasional side retaining walls, where the location is too narrow to admit of side slopes and where the adjacent property is too valuable to be purchased for slopes.

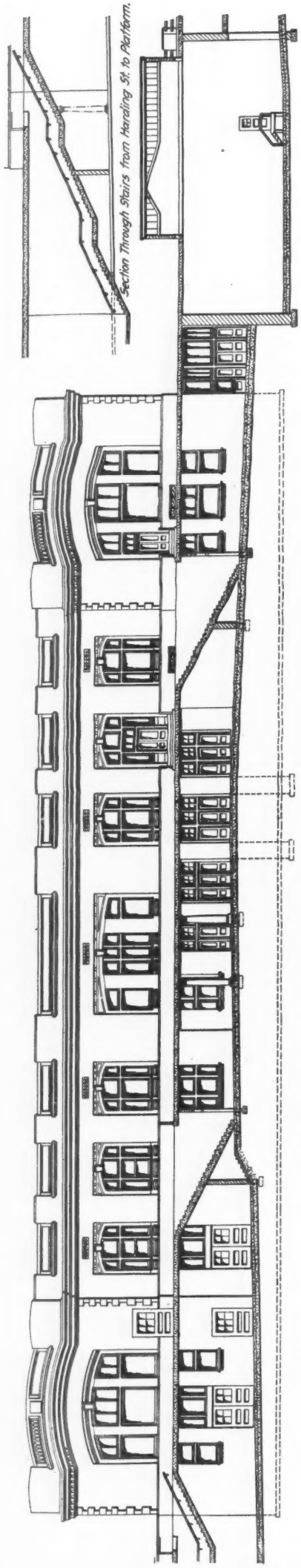
Beginning with Grafton street, which is located just west of the present Union Depot, the work is to be carried on jointly by the Boston & Albany and the New Haven to Worcester Junction, where the New Haven branches off toward the south. At this junction point the New Haven at the present time crosses the Boston & Albany at grade and it has been decided to eliminate this railroad grade crossing at the same time that the highway grade crossings are abolished. Beginning at this junction point, the New Haven tracks will pass under the Boston & Albany tracks with a clear headroom of 18 ft. and will ascend on an 0.72 per cent. grade toward the east on the north side of the Boston & Albany tracks (as shown in Fig. 1) until they meet the grade of the Boston & Albany tracks, about at the junction with the Viaduct. By relocating the New tric car tracks, is to be depressed only about 3 ft. The railroad, as at Grafton street, is to be supported on a masonry arch with a headroom of 16 ft., this clearance being measured from the crown of the street to the soffit of the arch.

Washington street will be depressed about 5 ft. and the railroad will be carried over the street by a solid floor steel bridge, the clear headroom to be 14 ft. At Plymouth street, where the present grades on the street are already steep, it has been deemed advisable to close the street to team travel, providing only a subway for pedestrians to pass under the railroad. This subway is to be 12 ft. wide and 10 ft. high, the outer walls to be of quarry-faced ashlar granite and the abutment walls to be of concrete, faced on the interior of the subway with white enamel bricks. The subway will be approached by stairs at either end, these stairs and the floor to be granolithic.

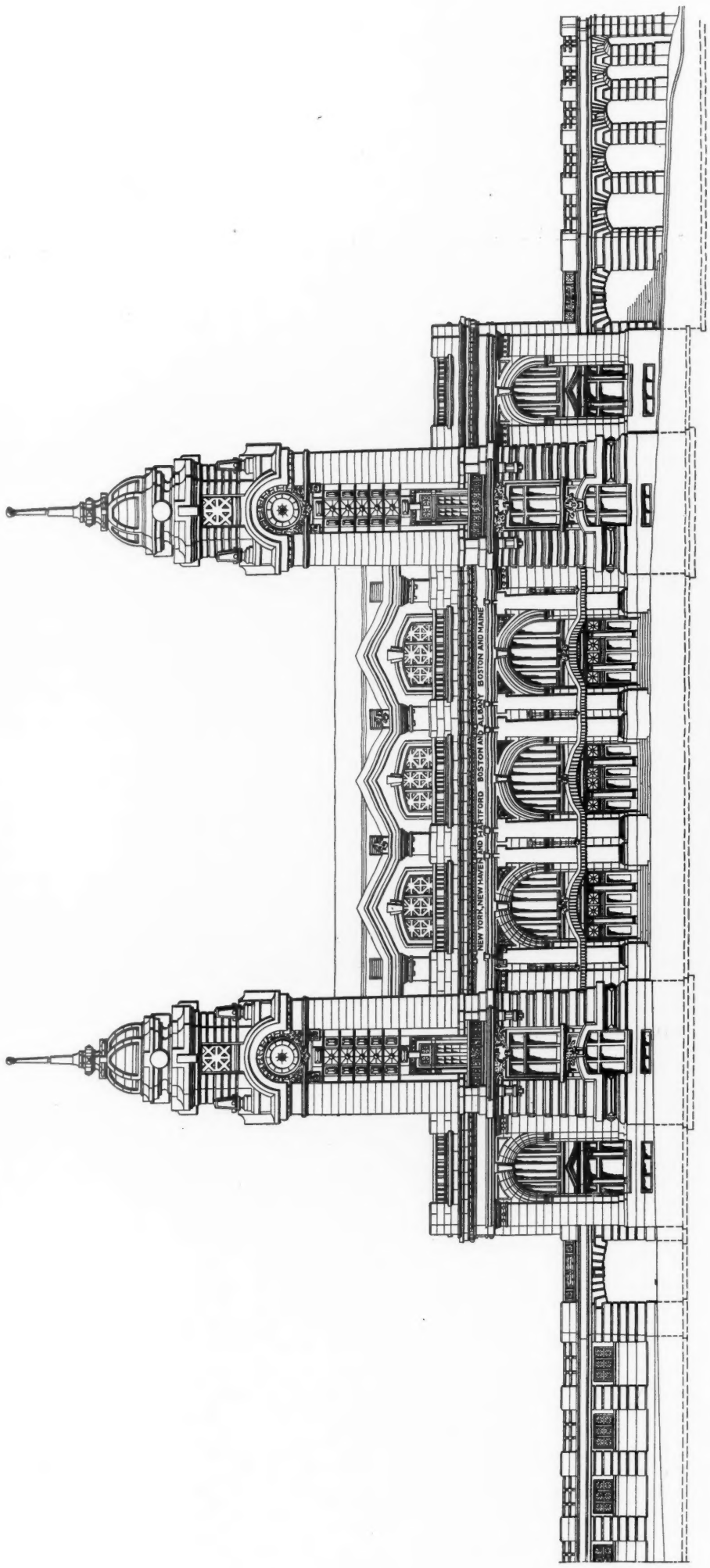
On account of the necessity of closing Plymouth street to carriage travel, Madison street, which does not now cross the railroad location, is to be extended and carried under the railroad by means of masonry arches whose headroom will be 14 ft. In a similar manner Hermon street is carried under the railroad with a headroom of 16 ft.

West of Worcester Junction there are but three grade crossings on the Boston & Albany; Hammond street, Gardner street and Grant street. At Hammond street it is proposed to leave the street at its present grade, and to carry the railroad above it by means of a solid floor steel bridge with a headroom of 13 ft. Gardner street is to be depressed about 11 ft., this heavy depression being necessary because the railroad grade has begun to fall rapidly so as to allow Gates street to be extended and to be carried above the tracks. At Gardner street a masonry arch with a clear headroom of 15 ft. will be constructed.

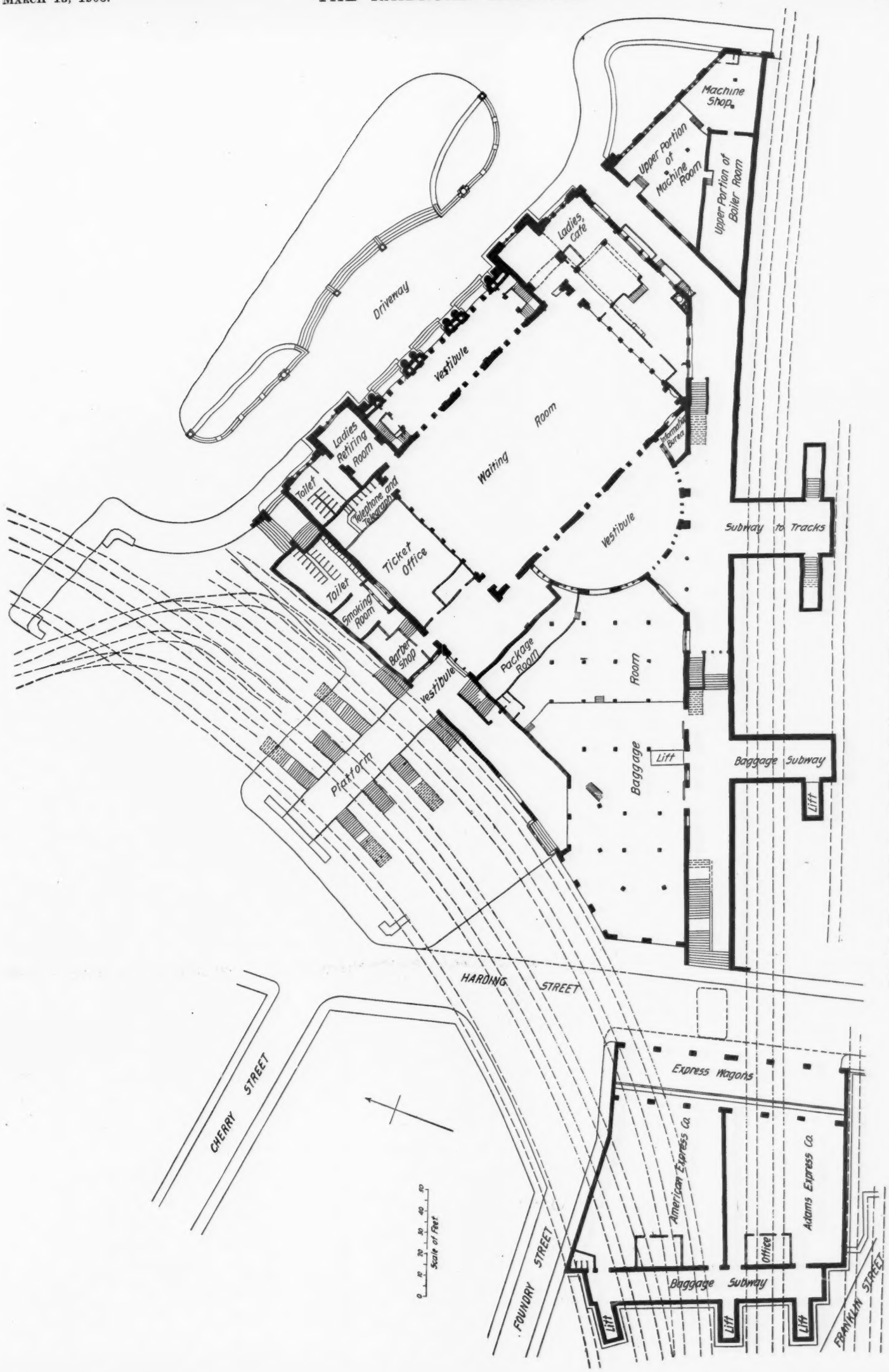
Grand street, which now crosses the railroad, will be closed to team travel; but a foot subway, slightly smaller but similar



Side Elevation and Section Through Subway; Proposed Worcester Station.



Front Elevation of Proposed Worcester Station.



Ground Plan of Proposed New Station at Worcester, Mass.

to that proposed for Plymouth street, will be provided. In partial substitution for Grand street, an additional street, Gates street, which does not now cross the railroad, will be extended and carried above the railroad crossing of the Boston & Albany by means of a steel highway bridge having a clear headroom of 18 ft. above the rail. On the southerly side of the railroad location this new street will branch and run in both an easterly and westerly direction connecting with Grand street and Canterbury street, as shown in the plan of Fig. 1.

These changes in street grades will in several instances affect the grades of adjoining streets, the most extensive changes being on Illinois street, where it is made to conform to Gates street. The proposed street grades are in some instances large. On Washington street, for example, the grade will be 5.75 per cent.; on Madison, 5.50 per cent.; on Hammond, 7.86 per cent., and on Gates, 5.60 per cent. These somewhat steep grades on Washington and Hammond streets are practically no steeper than exist on these streets to-day and neither of them is occupied by street car tracks. The steepest grade to be introduced on thoroughfares where street cars are operated is on Green street, where there will be a short 2 per cent. grade.

In all cases where the streets are to be depressed or extended, the roadways are to be paved to conform to the rest of the street, sewers are to be relaid and strengthened, and gas and water pipes are to be lowered where necessary, the latter to have a cover of at least 5 ft. of earth. The sidewalks are to be at the same grade as the roadway in all instances and to be paved in most cases with granolithic.

On the Norwich & Worcester line, the grade crossings at two streets, Southgate and Cambridge street, are to be eliminated as a part of the entire project. The grade of the New Haven tracks from Worcester Junction to Southgate street will remain practically unchanged, the railroad passing over Hammond street as at the present time, and as the grade of the Providence & Worcester line is not to be changed, Southbridge street, which now passes under the railroad, will be unaffected.

Southgate street, in its present location, will be abandoned except that a footway will be carried under the tracks. A new street, however, is to be constructed just north of Southgate street so as to pass under the tracks by means of a masonry arch which will have a clear headroom of 14½ ft., the grades of approach being 5.25 per cent. on the west side and quite flat on the east side where it runs to a junction with Southbridge street.

In a southerly direction from Southgate street, the grade of the railroad is to be depressed by a 0.20 per cent. grade until Cambridge street is reached, where the tracks will then be about 11 ft. lower than at present. Cambridge street is to be raised about 10 ft. so as to pass over these tracks with a clear headroom of 18 ft. The street will be carried over the tracks by a steel highway bridge with wooden plank floor, the grades of approach on both sides being 5 per cent.

On account of the elevation of the Boston & Albany tracks at their junction with the Viaduct it will be necessary to raise the entire Viaduct, beginning at the point where it joins the Boston & Maine and ending with a raise of about 15 ft. where it joins the Boston & Albany tracks. This will impose an up-grade of 0.55 per cent. in the place of a down-grade of about 1.3 per cent. on the portion of the Viaduct south of Front street. The grade proposed for the Viaduct between Front street and the Boston & Maine Railroad will be 1.42 per cent., which is a little steeper than the present grade. The Viaduct will be on an earth fill for the most of its length except the portion between Front street and Foundry street which will be built on a steel viaduct. Since these tracks already pass above the streets this extra elevation of this railroad will evidently require no change in the streets in that vicinity.

The tracks of the Boston & Maine from the junction of the Viaduct to the present union station will be discontinued and removed, and in the future all the trains both freight and passenger of the Boston & Maine will approach the new union passenger station over the Viaduct.

The new union passenger station (Fig. 3) is intended to be one of the handsomest and best planned stations in Massachusetts. Its proposed site will be nearer the business center of Worcester than the present station and its approach much more convenient. The foundations of the building are to be of reinforced concrete. On the granite base, which is to show about 7 ft. above the first floor level, will rest the exterior walls of light cream colored brick; the same brick is to be used for inside walls in the baggage rooms and toilets. The ornamentation for the exterior walls will be of dull finished cream-colored terra cotta. The building is to be fireproof throughout.

The floors of the main waiting-room and of the vestibules, restaurant and siderooms will be of cement. The waiting-room will be finished with a wainscoting of marble and with marble door and window finish to match, and the plastering is to be finished in imitation of Coen stone. All interior wood finish will be of red birch.

The staircases will be either cement or iron; the plumbing and lighting thoroughly modern. Subways and elevators are provided where necessary and there will be installed in the building the Kenney Vacuum System for cleaning as well as the necessary heating and hot water facilities for the restaurant. The architects are Watson & Huckel, of Philadelphia. It is estimated that this station will cost about $500,000.

In apportioning the cost of this entire work the grade crossing commission has decided that the Boston & Albany shall pay the entire cost of the site for the new union passenger station and also 65 per cent. of the total cost, including land damages, of all work west of Worcester Junction, and 32.5 per cent. of the alterations between Worcester Junction and Harding street, and also 65 per cent. of the cost of alterations east of Harding street.

The New York, New Haven & Hartford Railroad will pay 65 per cent. of the total cost of alterations, including land damages, on its railroad south of Worcester Junction, 32.5 per cent. of all work between the junction and Harding street, and 32.5 per cent. of the total cost of raising the Viaduct.

The Boston & Maine is to pay 32.5 per cent. of the cost of alterations on the Viaduct and 65 per cent. of the cost of removing their tracks from the junction with the Viaduct to the present union depot. The commonwealth of Massachusetts is to pay 25 per cent. of the total cost of all alterations ordered except the cost of the site for the new station and for constructing Harding street extension. The city of Worcester is to pay the entire cost of extending and building Harding street and also 10 per cent. of the total cost of all other alterations ordered by the decree.

In apportioning the cost that shall be borne by the street railways, the commission has decided that all public service corporations having rights in the streets within the limits of the alterations prescribed are to care for the several structures owned by them at their own expense.

The grade crossing commission which has finally brought this difficult problem to a solution is made up of the Hon. James R. Dunbar, Professor George F. Swain and Judge James H. Flint, the latter succeeding Henry P. Moulton, deceased. The cost of the entire project will be in the neighborhood of $3,000,000.

New Bridge Derrick Cars; Chicago, Milwaukee & St. Paul.

The bridge and buildings department of the Chicago, Milwaukee & St. Paul has recently built a heavy steel derrick car and some wooden derrick cars of unusual design and capacity. An illustration of each kind is shown herewith.

The steel derrick car is of 50 tons rated capacity, and is designed to allow construction of steel trestle work 80 ft. ahead of the trucks, or place a 95-ft. steel girder in position without the use of falsework. The car frame is structural steel. It is 51 ft. long over end sills and 9 ft. 10 in. wide over side sills. The frame overhangs the trucks 5 ft. on the boom end and 6 ft. on the cab end. The trucks are 40 ft., center to center. The boom is adjustable, its smallest length being made up of two 21-ft. sections. By the use of various combinations of 15 and 21 ft. intermediate sections this length can be increased successively from 42 ft. to 57, 65 and 80 ft.

30-Ton Wooden Underframe Derrick Car; Chicago, Milwaukee & St. Paul.

In the subjoined table the figures in the second column show the capacity of the boom for the corresponding length in the first column. The third column gives the distance the boom can swing from the track center line when carrying the respective loads shown in the second column and using the outrigger. The fourth column gives these distances when not using the outrigger. The lower end

of the boom swivels in a self-lubricating ball-and-socket joint bushed with phosphor bronze.

Length of boom.	Capacity of boom for this length.	Swing of boom — Using outrigger.	Swing of boom — Without outrigger.
80 ft.	10 tons.	26 ft. 9 in.	12 ft. 0 in.
65 "	20 "	19 " 6 "	8 " 6 "
57 "	35 "	19 " 0 "	8 " 3 "
42 "	50 "	15 " 6 "	6 " 9 "

The boom tackle is composed of two seven-sheave blocks with ½-in. side plates, reeved with 15 parts of ⅞-in. steel wire rope. The sheaves, which are self-lubricating, are 24 in. in diameter and have phosphor bronze bushings. The tackle supporting the 50-ton hook is composed of a five-sheave and a four-sheave block, with $^{7}/_{16}$-in. side plates reeved with 10 parts of ¾-in. wire rope. The sheaves are 21 in. in diameter, and, like the boom sheaves, are phosphor bronze bushed and self-lubricating. These blocks were designed and made by the railroad company. The A frame, when erected for operation, stands 21 ft. above the top of the rail. It folds back by revolving on a casting at its base, so as to reduce for shipment the height from top of rail to top of frame to 16 ft. 8 in.

The outrigger for increasing the capacity of the car for side lifts is an I-beam almost as long as the car is wide. It slides in and out of the casting at the foot of the A frame, and when extended affords a point of support 5 ft. 9 in. from the center of the track.

The cab frame, which is steel, is sheathed with common box car siding, and has a sliding front and folding side doors which afford ample view for the engineman and wide openings for exit. The cab contains a 50-h.p. hoisting engine, with two drums and four spools. Besides the air-brakes, the air-pump supplies four riveting hammers, at 100 lbs. pressure, from two storage tanks under the car floor. A propelling device and enough excess counterweight are provided to move the car with an 80-ft. girder at the end of a 57-ft. boom.

The 30-ton derrick cars are similar to some others recently built by the St. Paul, except the A frame, which has been added to the top of the tower to increase the effective height of the mast and thus diminish the stresses on the top tackle and boom. This A frame can be removed when the car is to be shipped, reducing the height of the tower to 15 ft. The car is of extra heavy construction, with center and side sills reinforced by 15-in. channels. In the attachment of the steel tower to the car there is provision for resisting any twisting due to side lifts by the derrick. The trucks also are extra heavy.

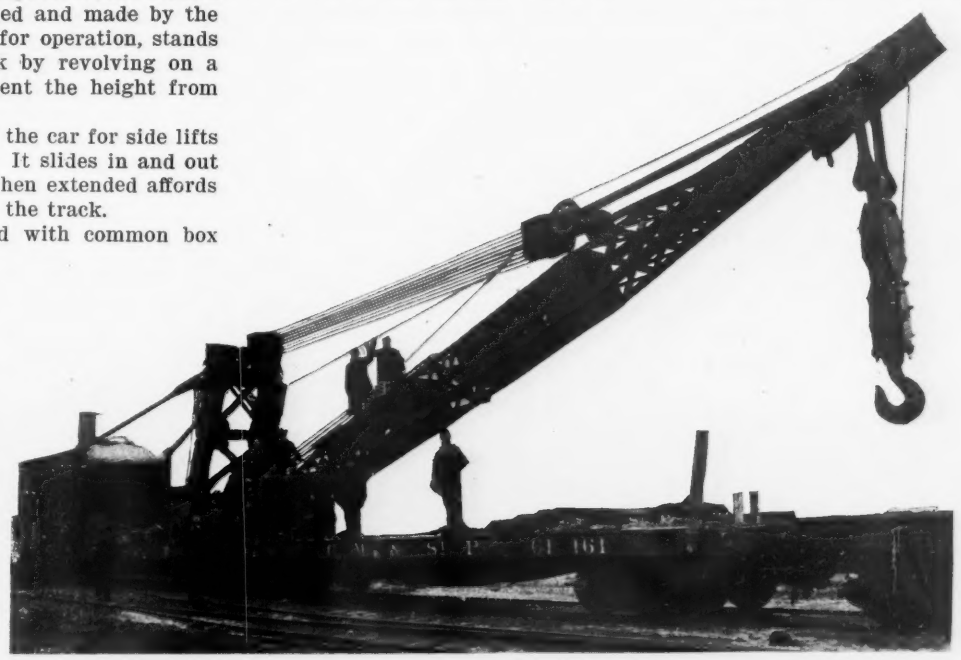
The tower has a foot-step for the boom at the base and a revolving connection at the top for the top tackle. These connections are in a vertical line, making the mast the greatest effective height which the height over all will allow. This latter dimension is limited by through truss bridge clearances. It is important that it should not exceed this height to enable the car to work in and around such trusses.

The top tackle consists of a four-sheave block fastened by eyebars to a forging. This forging revolves horizontally about a vertical axis, while the block itself revolves vertically on a horizontal pin. The other end of this tackle has a similar block turning on a pin which passes through plates on the boom. These connections allow movement in any direction without introducing eccentric stresses. A ¾-in. wire rope is used. The load tackle consists of three-sheave blocks and ⅝-in. wire rope, the rope passing over the end of the boom and back to the engine. The hoisting engines, water tanks, coal bins, etc., are so placed in the cab as to have the greatest effect as counterweights, and yet give enough working space for the engineman and winchman.

Equipped for work these cars will weigh 132,000 lbs., of which 74,000 lbs. is on the front truck and 58,000 lbs. on the rear truck. They are equipped with a self-propelling device attached to one of the rear axles. The weight on the rear truck exceeds the counterweight requirements by an amount sufficient to enable the car to propel itself while carrying a 70-ft. girder at the end of a 50-ft. boom. The rated capacity of the car is 30 tons at the end of a 30-ft. boom and 20 tons at the end of a 50-ft. boom.

These cars are fitted for any class of bridge work. One car can put a 70-ft. girder in place without falsework, and an 80-ft. girder in place using falsework. Two cars working together are needed for anything longer or heavier than this. One car has the capacity and boom reach to erect, without traveler, all single track through or deck truss spans of 260 ft., C., M. & St. P. specifications. The cars are part of the bridge and building department's erecting organization, which erects all of the company's bridges.

We are indebted to C. F. Loweth, Engineer and Superintendent of Bridges and Buildings, for this description.



50-Ton Steel Derrick Car; Chicago, Milwaukee & St. Paul.

Track and Ballast.

At a recent meeting of the Iowa Railway Club two papers on "Track and Ballast" were read, the first written by H. Rettinghouse, Division Engineer of the Chicago & North-Western at Boone, Iowa; the second by R. R. Auerbach, Roadmaster of the Chicago Great Western at Marshalltown, Iowa. These papers were followed by a discussion. An abstract of the papers and the discussion is given below.

Mr. Rettinghouse: Good track means first, good roadbed and drainage. Often I have seen carload after carload of gravel, cinders or other dry material put under track in some particularly soft cuts, only to churn up in a short time with the underlying soft mud. In such a case good judgment would dictate a little work on drainage ditches and tiling, with better results certain. Good drainage should be had in mind during construction of the roadbed, which should be built with extreme care. Ditches in cuts and along low embankments should wherever possible be made continuous and leading to the nearest outlets. Adequate waterways under tracks should be built. The question of drainage should be paramount. Modern engineering methods of determining drainage areas and the consequent volumes of drainage to be disposed of, are doing much toward perfecting drainage conditions and thereby helping to make good track. In the colder climates, especially where track maintenance is a difficult problem because of the heaving of track, there should be more attention paid to perfect drainage of roadbed, than at a location where frost does not penetrate deep enough to cause heaving of track. The roadbed should not only be perfectly drained, but should be of proper consistency to receive ballast and track, so that the material from it will have no tendency to churn up with the ballast after it is placed. If the material forming the roadbed is of such nature that it will not fulfil these conditions, it is often necessary to place a layer of cinders or coarse rock on top of it, so as to leave the ballast unimpaired.

Second, comes good ballast. The proper preparation of the roadbed and sub-grade is most important. The roadbed should be slightly sloped from the center line of track each way so as to permit quick drainage of such moisture as will penetrate through ballast. It is easy to do this with new beds previous to the track laying. When there is old track to be reballasted it is essential that the old ballast be removed from between the ties to the bottom of ties at the ends, and the excavated material leveled off to the shoulder of the roadbed so as to leave no ridges and leave no obstruction to the flow of sub-drainage.

Of the different kinds of ballast that have come under my personal charge and observation I will name the following:

(a) Broken stone or slag. (b) Gravel or sand. (c) Cinders. (d) Earth.

(a) Broken stone or slag.—From all points of view there is nothing better than stone ballasted track. Opinions differ, however, as to the size of crushed stone or slag. Some favor crushed stone averaging 2-in. cubes, washed so as to be absolutely clean and free from stone dust. Others advocate a size as small as ¾ in.; a mixture of all sizes between and including these two extremes; a crusher run article with a limit to 2-in. stones and a certain proportion of dust in the mixture. I advocate the last of these classes. I find that with broken stone or slag there is a tendency for the

sharp edges of the fragments of stone to bury themselves in the bottom of the ties through the impact of trains. It is difficult to keep track in good line through the further tendency of broken stone fragments to roll one way or the other. On lining track they tend to again crowd back and throw track out of line. With the mixed material this objection is reduced to a minimum and the smaller particles will fill out the voids. As to the small amount of dust, it will with a few rains wash down to sub-grade and by forming a coating over the sub-grade be helpful to drainage.

It is often held that broken stone or slag is too expensive as compared with gravel. I cannot agree with such an opinion as the one item of life of ties is an important factor in the cost of maintenance. The porous nature of stone ballast prevents its speedy fouling and thereby proves a long time investment. The thickness of stone or slag ballast and for that matter all other ballast should be no less than 12 in. from sub-grade to bottom of ties, while 18 in. is much better. The material should be hard and not subject to crushing. Limestones and granites, trap and flint rocks are most commonly in use. Only the hardest sand stones are admissible.

(b) Gravel and sand.—Good gravel which must be composed of stony parts that will not rapidly decay, and run in sizes from coarse sand to pebbles 2 in. in diameter, is extremely scarce. There must be no clay or earthy substance in it in order that it may drain freely and not churn when soaked by rain. The proportion of sand must not be too large nor must there be an excess of pebbles. The proportion should be about three parts sand and five parts coarse pebbles. These specifications are hard to fill. Utter and nearly ruinous disappointment has followed the opening of certain gravel pits, which were said to have been thoroughly tested, and on the strength of such tests bought at fancy prices, only to be found composed of three-quarters fine sand and one-quarter fair and usable gravel.

Good track can be made with gravel ballast. The ballast can be maintained somewhat more cheaply than stone ballast, but as it is less porous it will foul more speedily and will hasten decay of ties. Sand ballast is used only when other material is unavailable or on unimportant track. It is objectionable on account of the large amount of dust raised from it by passing trains, although excellent track can be made with it. The coarser the sand the better. The greatest objection to sand ballast is that it is less porous than other ballast and therefore greatly hastens decay of ties and fouls quickly.

(c) Cinders.—I know a railroad manager who will not allow the use of cinder ballast on either main or branch lines. He does not even favor it on passing or side tracks immediately adjoining main track. He objects to the so-called "sink holes," but his opinion is rather radical. I know of one important western railroad which has cinder ballast on several hundred miles on one of its most important main lines. Cinder ballast has been advocated as giving less resistance than any other and appears springy and therefore would make a good riding track. Because it is springy it requires frequent "picking up" and consequent renewal. It never gives the appearance of first class track and is for that reason tabooed on most of first class lines, though it is used a great deal on side tracks and industrial spurs.

(d) Earth.—Track ballasted with earth is in trackman's language called "mud track." It is well named. There is yet a good deal of earth ballasted track in this and other western states. I know of many miles of such track, which is really good as long as it does not rain, but when the rain comes down it is very poor track indeed. Maintenance of earth ballasted track is quite expensive and ties are eaten up rapidly. One big item of expense during the summer months is the removal of weeds.

Ties.—Good ties are essential to good track. All ties of soft as well as hard wood have doubled and trebled in price in a very few years. Economy in their use is therefore imperative. It requires good judgment on the part of section foremen and roadmasters not to jeopardize the safety of track for the sake of false economy. The percentage of oak ties used to-day is far larger than the soft wood ties such as cedar, hemlock and tamarack, and is greater than it was some years ago, notwithstanding the fact that many more miles of railroad have been added since that time and the total number of ties used enormously increased. Experiments are being made to find a substitute for wooden ties in steel or concrete, but as yet no satisfactory substitute has been found. The only salvation for the railroads seems to lie in planting trees and it is gratifying to see that many railroads are starting to do that.

Rails and Fastenings.—There is a great variety in fastenings. The old style fish plates have seen their day and the cast chair is a curiosity. The effort is to get a rigid joint. There is a little danger of overdoing this by creating such rigidity of joints as to overshadow the rail proper.

Good Men.—When the young Edwin Booth set out in his dramatic career, he went to an old actor with this question: "What must I do to play Hamlet? I wish to play Hamlet, I must play Hamlet, and I will play Hamlet." The old man, with the fire of enthusiasm in his eye, said: "Well, if you put it that way, if you want to play Hamlet, you must read Hamlet, you must eat Hamlet, you must drink Hamlet, and by the Gods you must *be* Hamlet." I have often said to a young man fresh from college who wishes to be a trackman and roadmaster: "If you want to be a trackman, you must read track, eat track, drink track and live track."

The American roadmaster or supervisor of track, as he is sometimes called, is a type distinctly of his own. Whether he has a college training or has risen from the ranks, in all cases he must be a good general, and above all a good trackman. Unlike his brother on the European continent, he has a comparatively large district under his charge and is always a busy man. Every wreck, every washout and every mishap demands his personal attention. It has become a serious problem of late to find section foremen, and this is at present one of the greatest difficulties with which the roadmaster has to deal. Most track laborers to-day are foreigners who offer no suitable timber for promotion, and it takes considerable discretion and ability of the foreman in dealing with that class of labor to accomplish what he is expected to do and keep his track in good condition. Railroads have seen fit to pay track laborers less than other laborers and as a result the intelligent and promising men in this department tend to go into other fields.

Mr. Auerbach: Cinders for ballast cannot seriously be considered by a road doing anything but a small business, although they are undoubtedly cheapest in the first place. When traffic is not heavy they do very well to widen narrow fills, to put in wet cuts and other weak places. These places can usually be repaired with the cinders that are made by the company using them. On a road using heavy power and running a good many trains a day, cinders are not a satisfactory ballast. They are altogether too light to stand much heavy pressure from above, and they are not heavy or compact enough to keep track in line unless an unusually broad shoulder is used. Consider the substance of cinders; the non-compact clinkers, the brittle and uneven stone-like pieces, and the almost powdered ash. Per cubic foot cinders weigh about one-fourth as much as gravel and one-sixth as much as rock. When cinders are used as ballast, the clinkers are not broken by the bar or shovel when tamped, but soon become crushed by the heavy weight of the rolling stock. You can dig down under ties where cinder ballast has been in for a year or more and you will not find one clinker. They become crushed by the traffic over them. This crushing puts the track out of line and subsequently out of surface. The track goes out of line because the weight of the cinder shoulder is not sufficient to hold it. To be sure track will always go out of line if allowed to get out of surface, or vice versa; but it will not get as much out of line or surface, or as easily so, with a stiff and substantial shoulder and a firm bed as it will with a light and loose one such as cinders give.

Cinders are best in wet places where there is a broad, flat subsoil such as yards. But on new dumps they are decidedly bad. The water easily drains through them, but does so mostly in certain places, forming pockets and cutting away parts of the dump. This year on my territory we filled some 20 bridges. Where cinders were unloaded on these filled bridges and rained on heavily, we had parts of the new dump cut away by an unequal amount of water going through the less compact part of the cinders. I unloaded 200 cars of cinders on one section this summer. The cinders were put under as fast as received. Two months after they were put in, leaving a good top and line on track, it was necessary to re-raise this track. This was done about September 1, and track is in such condition now that it will have to be gone over again in the spring. The ground formation under these cinders is of the best. Cinders in yards are excellent. They drain well, are hard and present a good appearance if kept clean.

Ballast cannot be entirely taken away from a track. Roads that are dissatisfied with their cinder track and want to improve it should put gravel on and reballast it. I have seen gravel put on over cinders with excellent results. The coarser gravel very soon forms a cushion with the cinders.

Gravel or rock? This is the vexing question.

Gravel.—The reasons for having coarse gravel for ballast are obvious. With fine gravel there is too much sand. The sand washes, is dusty and while the fine gravel is almost as heavy as the coarse, it is not nearly as substantial or enduring. It cannot be tamped to give as firm or lasting a bed as gravel made up mostly of stones about the size of the end of your finger, because the large amount of sand found in the finer gravel will work out when dry, and when wet will churn.

Coarse, pure gravel is considered by many to be the ideal ballast, but let me surprise some by saying that if a small amount of clay is added to this gravel we have more nearly a perfect ballast. The need of this clay is not so apparent in newly ballasted track, but as the track gets older and parts of the gravel wash away and rain begins to form small ditches in the shoulder of it, then it becomes noticeable that the gravel has not packed hard enough to turn water or to leave it as originally dressed. But if mixed with this gravel is about 10 per cent. of clay, just enough to cement it, rains will not affect it, and the older it becomes the harder it

gets, forming a strong, cement-like shoulder and bed. It can be maintained with less work and expense than any other ballast. I can show you four miles of such ballast on a trunk line in this vicinity that has not been touched for three years, and is at present in as good line and surface as any track in this part of the country. I can also tell you of a large road in this state that has coarse gravel for ballast, which has issued instructions to its section men that they should, whenever possible, mix with the gravel a small amount of clay. However, great care must be taken that there is not too much clay in the gravel, as too much would be worse than none at all, for in wet weather the track would churn and work.

The cost of maintenance of gravel ballast is approximately the same as for cinders and the finer grade of gravel, except that it does not have to be gone over so often. What I mean to get at in comparison to rock is that a light raise of joints or centers can be made. I might add here that, except rock, track should be lifted as little as possible, and should never, if it can be avoided, be raised out of face. The old tie bed made by years of service is always preferable to a newly made one.

Rock.—It is true that from section men to roadmasters comparatively few handle crushed stone intelligently. The reason is, rock ballast is comparatively new to us. There is a vast difference between rock and the nearest thing to it, coarse gravel. Rock track cannot be kept up with less than from 10 to 15 per cent. more force than is necessary to maintain gravel or any other ballast the year round. You cannot lift a joint here or a center there in rock. It must all be taken out of face. That is, you cannot make a light raise of a joint or center, such as a half inch, because the dimensions of crushed stone generally used cannot be got under such a light raise, and in order to get up the low place of a half inch you must raise it higher than necessary to make it level with the rail on each side of it; consequently, in order to get a true surface you will have to raise the rails adjacent to this joint, and so on, and in doing so you are lifting the track out of face, or making a new cushion for it. It is impossible to make light raises and keep them up. You cannot get under enough ballast to hold them. You lift a joint only. The quarters on each side will come up somewhat, too, and there is no crushed rock small enough to put under these quarters where the joint is raised a little. But still you will find foreman after foreman trying to do this kind of patchwork on rock track. It is simply time wasted.

In rock track you practically have no choice of the quality of ties. Nothing but oak or ties of equally hard wood should be used. Rock on a solid formation will penetrate softer ties, shorten their life, and ultimately affect the surface of the track. In the maintenance of rock track too much attention cannot be paid to the way in which the ties are tamped. No track becomes so easily centerbound and swinging as rock. Ties in rock should only be tamped at the ends and under the rail, never in the centers. Don't try to do this tamping with anything but tamping picks. Bars are not properly shaped and shovels are out of the question. Rock track should always be lined before being raised. Raising track before lining it will invariably disturb its surface. Compared with other ballast the care of rock track is very slow. But when once laid it will remain that way for some time, and the force caring for it can be reduced half until such time as it requires attention again. Perhaps this possible reduction of half the force when rock is in good shape would seem to lessen the cost of maintenance of rock to equal that of other ballast. But on the other hand the additional force required to put rock in good order when it is partly run down more than offsets by from 10 to 15 per cent.

The best feature of rock ballast is its drainage. Nothing short of a cloud-burst will affect it, and churning and working track is unknown. I have in my territory about two miles of track on a hill that washed out every time there was an unusually hard rain. It was so situated that the water poured on it from the adjacent hills. We had both gravel and cinders on this piece of track. That is, we had them from one washout to another. We finally put rock ballast in, and since then have never been troubled with washouts. I might mention here that this piece of rock track, two miles long, has not been raised or lined for two years, and is in good shape now.

Mr. Rettinghouse: There is one point in the last paper that I cannot entirely agree with. The claim was made that the best track men would not disturb track after it has been once settled. I have found in my experience that the raising of the joints was always considered as an expedient. We go over a piece of track every year, and if the material is there we always have found it better to raise the track two or three inches and it would keep the track in better shape.

Mr. Farquharson (Roadmaster, Chicago, Rock Island & Pacific): It is all right to raise track if you don't raise it too high, but enough so you can bar tamp it. But when you raise it so you can't bar tamp it, the places where it is settled away will have to be bar tamped to make good track. Two or three inches would make good track with bar tamping.

Mr. Hayes (Roadmaster, Chicago, Rock Island & Pacific): In 1905 I made some tests for gravel ballast. It was almost entirely under water on the Coon river, what would be called a practical well-washed gravel. We put a large amount of this in track in 1905 but found that the gravel did not hold as well as it should because there was not enough clay in it to bond. Therefore it has not given good satisfaction. We have been using a large amount of gravel the last year or so which gives good satisfaction and which has a certain amount of clay which causes it to bond. I think gravel ballast is a great deal cheaper than rock and gives just as good satisfaction.

Burnt gumbo has not been mentioned. I think from experience that it gives about as good track as you can want with as small an amount of attention as any other and less attention than gravel requires. It costs a little more in the beginning.

Mr. Jones (Superintendent, Chicago, Rock Island & Pacific): A good track man has the same opinion of water that the devil has of holy water. He wants to get rid of it as quickly as possible. Some experience we have had in the last two years on our road may be of value. Our dumps were pretty narrow and also the cuts, so that all the water that fell near the track ran down on it. It was impossible to secure money necessary to widen our cuts with steam shovels and use the material taken therefrom to widen our banks, so we were forced to take care of it with tile. On our division we have put in the last two years something like 27 lineal miles of tiling, using sizes from 4 and 6 to 8 in. In placing the tiling we put it as nearly as possible in the bottom of the cut, which, as the cuts were narrow, was from 3 to 4 ft. from the end of the ties. We put the tiling from 3 to 4 ft. below the bottom of the tie and gave it a good drainage from the center of the cut to each end, making the ditch we dug to place the tile as narrow and as straight as possible. Then we filled our ditches with cinders from the top of the tile to the bottom of the ditch. The result has been that with the heavy downpours of rain or cloudbursts which we have occasionally in Iowa, there is little if any water that runs on the surface of these ditches out of the cuts. The water goes down through our cinder bed and into the tile and runs out through the tile instead of over the surface, the result being the water does not get much opportunity to get into the track or dump through the cuts and we have secured with a small outlay what we consider the best possible results from this method.

Burnt gumbo is too expensive in this part of the country because of the price of coal and high comparative cost of slack. There was a time 20 years ago when coal mines were glad to give the railroads the slack for hauling it out and some coal mines paid the railroads something for hauling it away. At that time the burnt gumbo could be made at a very reasonable price, as the principal cost is the burning of it for ballast. A couple of years ago some burnt clay we burned because we had to carry coal so far and paid so much for it, if I recollect it correctly it cost close to $1.50 per yard deposited on the roadbed for placing under the ties, making an almost or quite prohibitive figure for that class of ballast.

The ballast Mr. Hayes speaks of that we got from the Coon river, river washed gravel near Commerce, I think we placed under the ties for approximately 43 cents a yard. I think it was figured 43 or 43½, and that included the cost of loading the ballast which we were able to load at about 6 cents per yard, and we hauled that 70 or 75 miles. During the summer of 1906 we put in nearly 60 miles of Grettinger ballast which we hauled I think 250 miles, paid a foreign railroad company a pretty heavy mileage, and my recollection is that it cost, loaded by steam shovel, 3 cents a yard and cost us 72 cents a yard placed under the ties at that distance. Stone ballast ordinarily costs considerably more than that, at least 50 to 75 per cent. more. In this country I believe it is extremely difficult to get a first class quality of solid rock, and unless you do, it is very expensive and makes mighty bad track in a short time. The softer particles disintegrate very fast from the moisture and the frost. Then they break and pump under the joints in a short time. I know of stone ballast put in within two or three years in an adjoining state which at the time was considered very good ballast, but within the last six or eight months they have been compelled to ditch at almost every tie and joint allowing the water to get away from the track on account of disintegration. Yet it was considered fairly good rock at that time.

These papers have stated the differences between maintenance of gravel ballast and rock ballast too closely. I believe it must cost us at least 25 per cent. more to maintain rock ballast than gravel and from 75 to 100 per cent. more to change out ties in rock than it does in gravel ballast. The ballast we secured that Mr. Hayes spoke of being river washed has proven rather unsatisfactory ballast. As mentioned in one of the papers it is "alive," we can't tamp it with a bar because if we do we drive it out from the other side of the tie and we can only shovel tamp it. I am satisfied, however, that this ballast is getting better. It has been in now over two years and it is getting better because the dirt and clay blown or carried in is becoming mixed with it and holds it in bond. The Graettinger gravel has a fair quantity, perhaps from 5 to 10 per cent. of foreign matter in it, that is, a sort of a clay, more like a disintegrated iron ore, and that gravel in a very few

weeks or months at least after put on a track will become perfectly solid almost as much so as disintegrated granite, which without question is the best ballast that is in use to my knowledge.

I think the gentlemen in their papers where they have spoken so harshly against cinders have gone a little too far. Cinders without any question are "the poor man's friend," and we have cinder ballast on our railroad under heavy traffic, under heavy engines; one stretch I recall of some three miles put in two years ago last spring about 12 in. under the ties still remains good track and the section on which this three miles of cinder ballast is located, averages one man, besides the foreman, during the past season because we could not get men in that vicinity because the other railroads were paying higher wages than we were permitted. They may have lost sight of the fact that there is a great difference in cinders, perhaps greater difference in cinders than in gravel. Some coal makes ashes almost entirely, with some clinkers mixed in. Other coal makes hard sharp cinders and the hard sharp cinders in our experience do not disintegrate and bed down as explained in the papers, and while cinders are not so good as rock nor as good as gravel, they are better than poor gravel and they are much better than no ballast at all.

Mr. Rettinghouse: I believe I said in the paper that my experience was limited to that one instance and also that the suggestion had been made to wash all gravel. I got this information from the proceedings of the American Railway Engineering and Maintenance of Way Association of a few years since, but there was nothing said about the outcome of that experiment. It reminded me of that one instance where we used naturally washed gravel. The statement has been made by Mr. Jones that he found track that was ballasted with such washed gravel improving through the addition of clay. It is evident that you are not much bothered with heaving track in this vicinity. My experience has been in a very cold climate and heaving track was one of the greatest troubles we had. The minute we put any particle of clay in our ballast we would have a great time. I have seen track heaving so much that it required a full sized tie each side of the heave. Consequently it heaved over 6 in. This was all due to poor gravel or clay sub-soil. If there is no trouble with heaving, perhaps clay would be best.

The exchange of ties or renewing of ties in stone ballast will cost a great deal more than in gravel ballast. The cost of gravel ballast depends on the equipment at your disposal. That is to say the kind of steam shovels and ballast cars and the methods of unloading, etc. It is a most important item, as every practical man will know, to have the equipment as perfect as possible. In the years 1905 and 1906 I was in charge of track in Wisconsin and no expense was spared. We had some very large steam shovels with 5-yd. dippers; we had ballast cars, side dump cars; Lidgerwood unloaders, any quantity of them—no scarcity of equipment whatever. We had spreaders that were operated with air, and as a consequence I think that we handled our gravel about as cheaply as it could be handled, and I think it came very near to the figures mentioned by Mr. Jones, so I presume he had the same kind of equipment. We ballasted about 60 miles of single track with a yardage of 4,500 to the mile, which is very heavy ballast indeed, amounting to practically 18 in. under the ties. That ballast cost us from 29 to 33 cents a yard for different sections and depending on the haul. I had in the same year another stretch of 10 miles with a different kind of a ballast where the cost ran up to something like 50 cents a yard. It was because we had to haul over another road, and our calculation as to the number of trains we could haul each day was knocked in the head. Instead of hauling four trains I could only get three through, and of course that means a whole lot of difference. The cost of broken rock ballast is I think safe to assume a dollar a yard as an average cost, meaning the entire cost of the production of rock, hauling and putting under the track. We have on the North-Western now a crusher near Cedar Rapids which has been put in operation in the early spring, and we have not produced this year the rock as cheaply as we should. A great deal of that is due to the fact that much more stripping was necessary than we first anticipated. We will undoubtedly get the cost down during the coming year to about 40 cents a yard and perhaps less. It should be gotten out for 35 cents a yard. In that case the rock ballast track should not cost more than 75 cents a yard complete, figuring on a 40-cent basis. It should be put in for 25 cents a yard and we figured 10 cents for hauling.

I mentioned in my paper broken stone and slag as you notice, but I had particular reference to the Chicago & North-Western track between Chicago and Milwaukee. I don't know whether any of you gentlemen have traveled over that line, but it is said to be one of the best tracks in the country. The trains are very fast and very numerous. I believe that most of that distance, some 83 miles, is ballasted with broken slag, obtained from the rolling mills in that vicinity.

Mr. Breheny: Drainage I consider primarily essential. From my observation of the results from placing tile in some of the wet cuts recently, I am about ready to believe that considering the expense to which the managements feel able to go, that it is a very good alternative and very satisfactory. As to the cinder ballast, I must take exception to what the papers infer or intimate, for I believe that the cinders from the Iowa coal when a sufficient amount of it is put under the ties with a good sub-grade and provision made for good drainage, and track properly put up, that it does make a comparatively good riding track and the maintenance expense is nominal, about equal to gravel. The quality of the cinder is no doubt to be considered in this respect. I did have a little experience this summer with cinders made from Colorado coal which approaches very nearly a lignite in lightness. The cinder is so light as to be almost entirely unsuitable as ballast. In the second paper on ballast I notice at the outset the use of cinders in wet holes is suggested, but later condemned in arguing against placing cinders where they will produce a pocket. I believe if you put cinders in a wet hole in an embankment and the track continually settles it will produce what is called a sore spot.

With the rock I believe that the class of soil making the sub-grade should be considered. There are localities in Colorado where the sub-grade is a gumbo or material known as "doby," and the slag or rock is shown by experience to be too heavy in that it settles very readily into the "doby" and the "doby" works up around the end of the tie and you have got to be continually digging it out and refilling. We found by experiment that it was impracticable to place anything heavier in the way of ballast than cinders or disintegrated granite.

Disintegrated granite is the best ballast I have seen. Rock ballast is no doubt first class, but I do believe it has a rigidity that is not experienced in the riding of gravel or cinder ballast. It has an effect very close to that produced by slag. The slag in the vicinity of Denver or Pueblo is not used as much for ballast as might be expected considering the quantity in which it is furnished, and when asking as to why this is so the majority of the answers were that it was too heavy for the sand or "doby" sub-grade and they did not consider it provided as good a ballast for the locality in which it was burned as did the disintegrated granite. The expense of the disintegrated granite, both in its original cost and considering its ultimate cost in the maintenance, compares favorably with that of our gravel, and while it is in itself a material that drains well, yet I believe that in a proper cross section there can be exceptionally good drainage. In the locality to which I refer the slag was used for the most part in rip-rapping, protecting embankments, covering trestle bridges as a protection against fire hazard and comparatively little of it under track as a ballast. The disintegrated granite is readily obtainable, works nicely, and we found by experience that it was a little more easy to secure labor to work in the disintegrated granite than it was where stone or slag was used as a ballast. This is possibly a feeling that existed in that locality only. We got the disintegrated granite from the Colorado Springs & Cripple Creek District Railway in the North Cheyenne canyon, beginning at mile post 5, about five miles up in the hills from Colorado Springs. The available granite pits have been worked out from that to mile post 8, three miles.

The Illinois Central's Birmingham Line.

The Illinois Central began active investigation for a line to Birmingham, Ala., early in 1901. The topography of the region presents many difficulties to railroad construction, and to determine the feasibility of a line from some point on the present line required careful investigation. Surveying parties were put in the field in 1902, and a number of routes projected from points all the way from Jackson, Miss., to Jackson, Tenn., on the existing line. As a result of these surveys, the most feasible location appeared to be between Jackson, Tenn., and Jasper, Ala., 176 miles, by way of Tuscumbia and Sheffield, passing through Chester, McNary and Hardin counties in Tennessee, Tishomingo county in Mississippi, and Colbert, Franklin, Winston and Walker counties in Alabama. It was decided to make traffic arrangements with the Frisco System between Jasper and Birmingham, 41 miles. The line, as located, followed the general direction of the headwaters of Deer river out of Jackson, through Madison and Chester counties, ascended to the summit of the divide between the valleys of the Mississippi and Tennessee rivers in Hardin county, and thence descended to the valley of the Tennessee river and followed it to Tuscumbia, 104 miles. At Tuscumbia, the line broke sharply from the Tennessee valley and ascended to the top of Sand mountain, the watershed between the Tennessee and Black Warrior rivers, near Double Springs. From Double Springs south, a tortuous descent was made into Jasper by way of the valleys of Sipsey and Clear creeks, both tributaries of the Black Warrior. The maximum grade on this section was 1 per cent., and the maximum curvature 4 degs.; but from Jackson to a point 17 miles south of Tuscumbia the maximum grade was only 0.5 per cent. and the maximum curvature 3 degs. The air line distance from Jackson to Birmingham is 184 miles and the distance by the location described is 215 miles. The 176 miles of

this to have been built would have cost about $10,000,000, or $50,000 a mile.

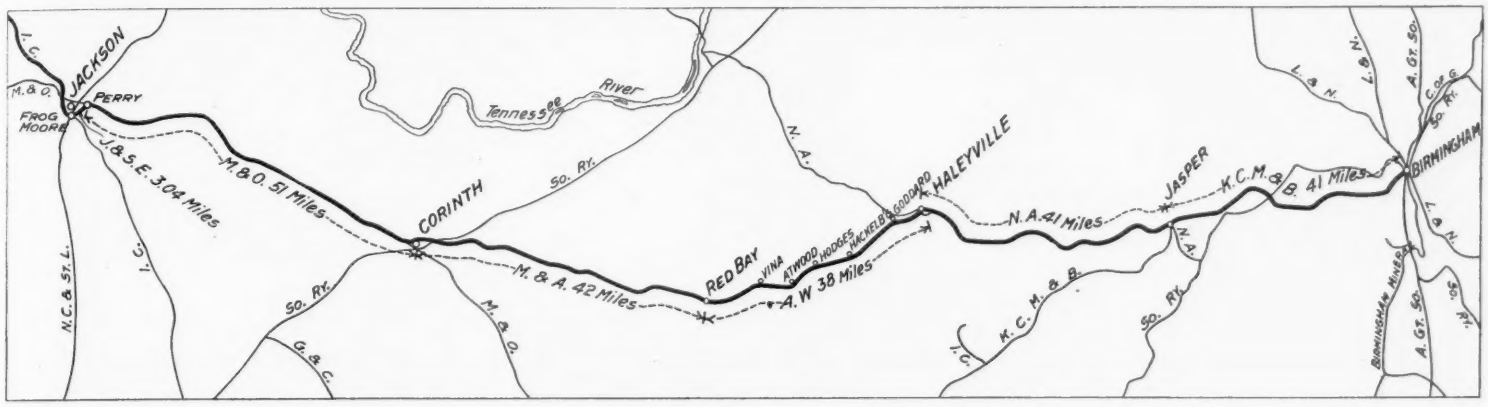
The financial depression of 1904 deferred further action in the matter until the spring of 1905, when arrangements were made for the following trackage rights:

Mobile & Ohio from Perry, Tenn. (near Jackson), to Corinth, Miss., 51 miles.

Northern Alabama from Haleyville, Ala., to Jasper, 41 miles.

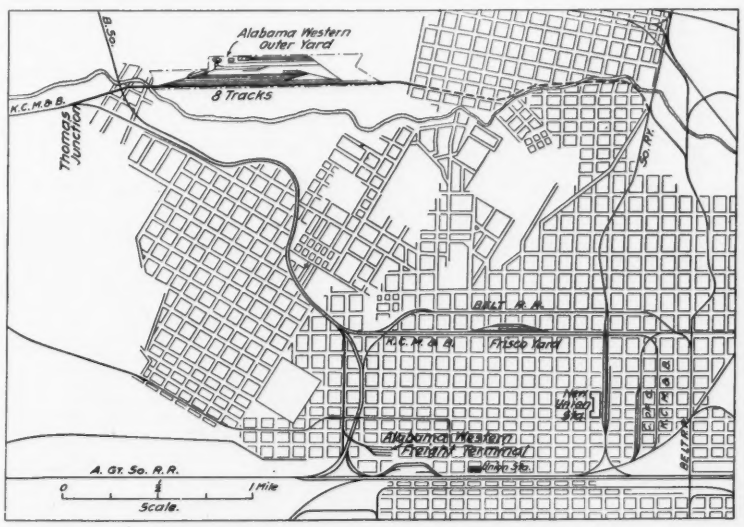
Kansas City, Memphis & Birmingham from Jasper into Birmingham, 41 miles.

This lessened considerably the mileage to be built. It was necessary only to build a connection 3.06 miles long with the Mobile & Ohio at Jackson; a line 80.1 miles long, leaving the Mobile & Ohio at Corinth and connecting with the Northern Alabama at Haleyville; and freight terminals in Birmingham. The connection at Jackson presented no particular problems in railroad construction, being a standard single-track line laid with 85-lb. rails on gravel ballast. The corporate name of the line is the Jackson & Southeastern Railroad.



Birmingham Line of the Illinois Central.

The line from Corinth ascends directly to the top of the ridge dividing the watersheds of the Tombigbee and Tennessee rivers, known locally as the "dividing ridge." This ridge is cut up by cross ranges of hills of moderate elevation, which are well wooded but without undergrowth. They are made of clay, with an occasional seam of sandstone. The location continues on the top of this ridge into northern Alabama, striking the Northern Alabama at Haleyville. The section traversed in Alabama is a portion of what is known as "Apalachian America," and the foot-hills of the Blue Ridge



Railroad Terminals in Birmingham.

mountains. This district has been referred to as the "land of saddles and bad roads," where a great variety of climates prevail, and where there is a survival of pioneer conditions, woodcraft and the open fire-place with the "stick and mud" chimney—in every way an unpromising land for railroad building. The line runs through Alcorn, Tishomingo and Ittawamba counties in Mississippi, and Franklin, Marion and Winston counties in Alabama. The part in Mississippi, 42.28 miles, was built under the corporate name Mississippi & Alabama Railroad, and the portion in Alabama, 37.82 miles, under the name Alabama Western Railroad.

While the line is laid on the dividing ridge, it, nevertheless, involved very heavy grading to get the kind of line desired, that is, a maximum grade of 26.4 ft. to the mile, compensated .04 per cent. per degree of curvature, with an additional compensation of .01 per cent. for half a mile each way from passing siding stations. The maximum curvature for the line is 3 degs., except for one curve of 4 degs., 2,085 ft. long, near the Haleyville end, which was necessary to secure the most economical location for crossing Brush creek. All curves of 2 degs. and over have spiral easement approach curves. The profile, parts of which are shown herewith, gives a clear idea of the work encountered, and the accompanying photographs show the nature of the cuts which were made. The geology of northern Alabama according to the authorities shows sub-carboniferous rock masses and coal measures. As a matter of fact, however, very little rock was encountered in large masses, but many of the cuts contained disintegrated rock, cemented gravel and rock seams separated by clay and sand. In certain cuts this clay was indurated and very difficult to remove.

Stephenson Hill cut, stations 3,991 to 4,022, near Corinth, and Chub Hill cut, stations 1,781 to 1,798, shown in the illustrations, are two of the largest cuts on the line. The former contained 196,000 cu. yds, and the latter 106,000 cu. yds. Besides these, there were numerous cuts of over 100,000 cu. yds.; the fills were correspondingly large, as the line was built on a balanced grade line. The total material moved on the entire line from Corinth to Haleyville was 5,500,000 cu. yds., or about 70,000 cu. yds. to the mile.

Near the Haleyville end of the line, Brush creek, a small tributary to the Tennessee river, cuts a wide, deep gap in the dividing ridge, and it is here that, after thorough study and careful investigation requiring numerous preliminaries, it was decided to cross the gap by a steel viaduct, in preference to increasing the length of the line by staying on the top of the ridge and building around the gorge into Haleyville. The general dimensions and weights of this viaduct are:

Total length, face to face of parapets	1,230 ft. 7¼ in.
Maximum height, base of rail to masonry	171 " 2 "
Total weight of structure	1,943 tons.
Total amount of masonry	1,550 yds.

It consists of ten 75-ft. deck plate girder spans, nine towers with 40-ft. deck plate girders, and two 60-ft. deck plate girder approaches. The 60-ft. approach spans rest on concrete abutments and rocker bents. The towers and rocker bents rest on masonry piers on solid rock foundations. The tops of the piers are all 5 ft. 6 in. square, varying from 6 ft. to 24 ft. in depth, according to conditions. The masonry piers are all stepped on the outside to permit future extensions to the masonry for a second track.

The tower spans are fixed at both ends on the columns and the 75-ft. spans on each side are alternately loose and fixed at the ends. The towers themselves are fixed at diagonally opposite corners of the bases, expansion being provided for at the other corners. Each of the towers consists of four columns joined by diagonal braces of channels. Each column is made up of two plates and four angles. Two angles are riveted to each plate, the two plates being spaced 21¼ in. and laced with 3-in. x 2-in. x ⅜-in. angles. The towers are built in one, two or three sections, according to the height. The top sections, the middle sections, and the base sections, respectively, for all towers, are built of similar elements. The steel for the viaduct was furnished by the McClintic-Marshall Construction Co., Pittsburgh, Pa. It was erected by the Strobel Steel Construction Co., Chicago, with a double trolley traveler, as shown in one of the photographs herewith. The total time from beginning the work of erection until trains were allowed to cross the viaduct was 40 days.

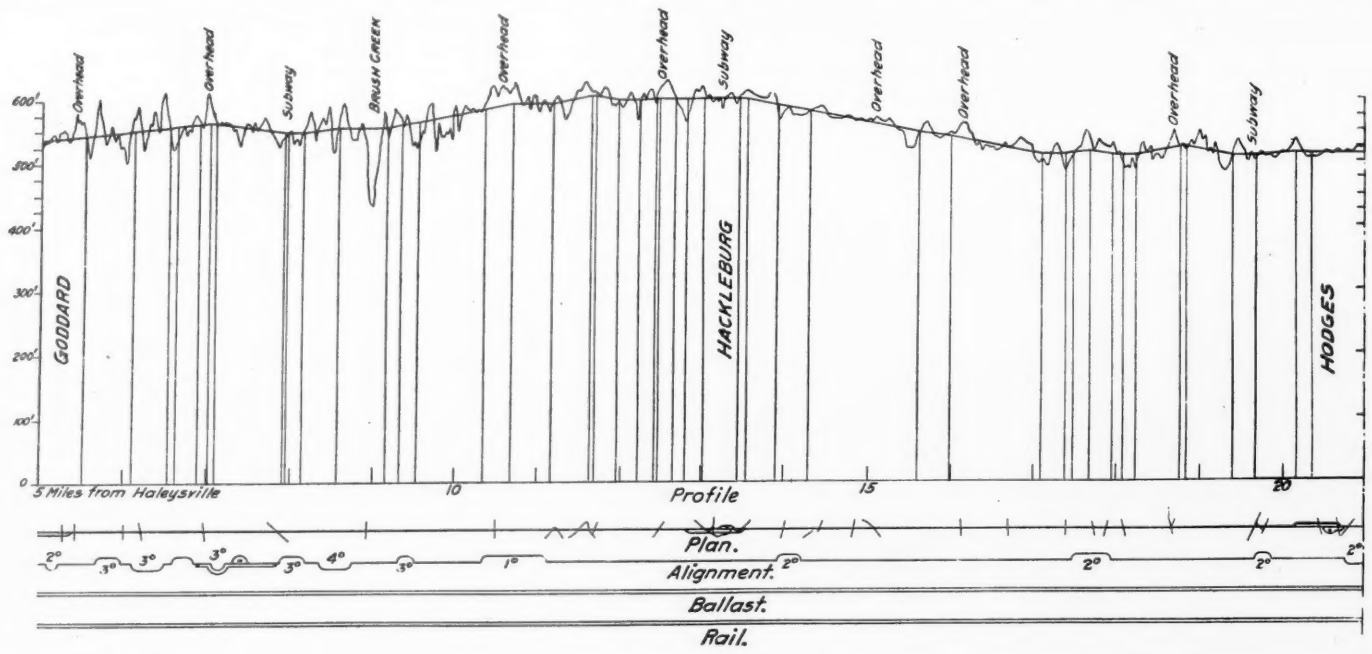
The design of the columns in the present towers allows for future double-tracking of the viaduct by erecting additional columns on each side. To install this second track, the masonry will be extended and additional columns placed and connected to the present columns by struts and diagonal braces, and one additional deck plate girder span will be added to each side of the viaduct 8 ft. from the center line between the present girders, the present track being moved to one side so as to rest on one of the present girders and

one of the new girders. The new track will rest on the other two girders, one new and one old.

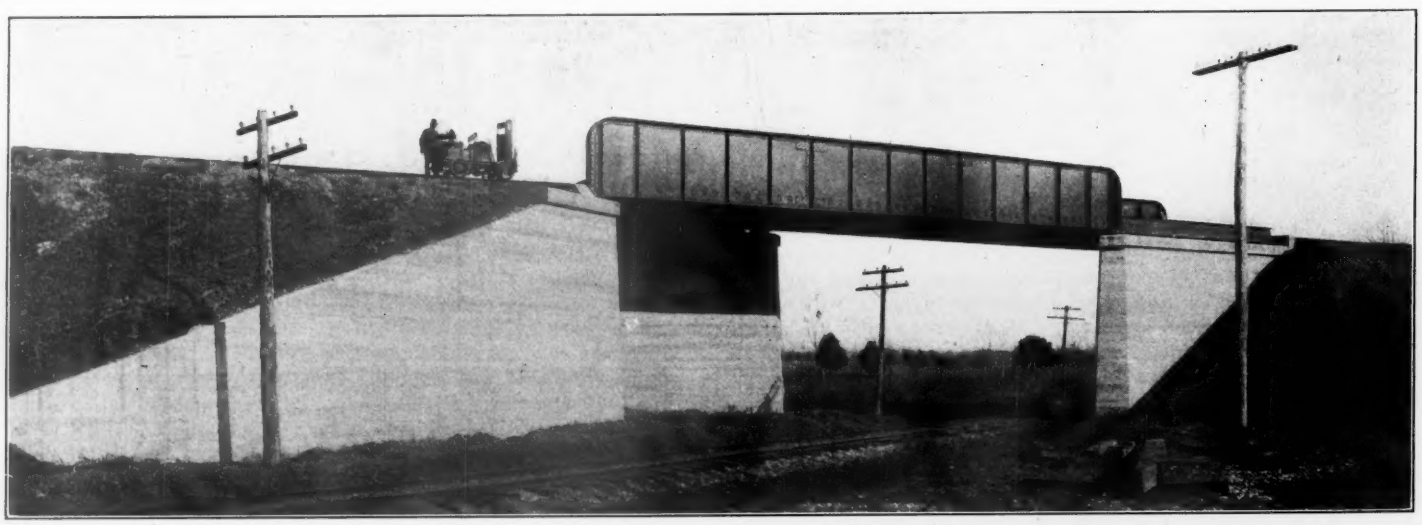
The Brush Creek viaduct and the overhead crossing of the Southern Railway are the only noteworthy bridge structures on the line. The Southern Railway crossing, which is the only railroad crossing on the line, is a through girder bridge, 71 ft. long, on concrete abutments. All other bridging is Illinois Central standard six pile, open deck, single-track trestle. The smaller openings have cast-iron pipe.

The buildings for the line are in keeping with the kind of country in which they are located. The depot and office building at Corinth, shown in the illustrations, is a combination freight and passenger station, with operating officers' headquarters on the second floor. The local stations have combination freight and passenger depots of a size suitable to the needs of the community. A cotton platform and a stock pen are provided at each station.

The section foremen's and agents' houses, which are alike, are story-and-a-half frame structures, designed to afford comfortable living quarters in a warm climate. They have two large living rooms, 16 ft. x 16 ft., separated by a wide hall leading to a porch

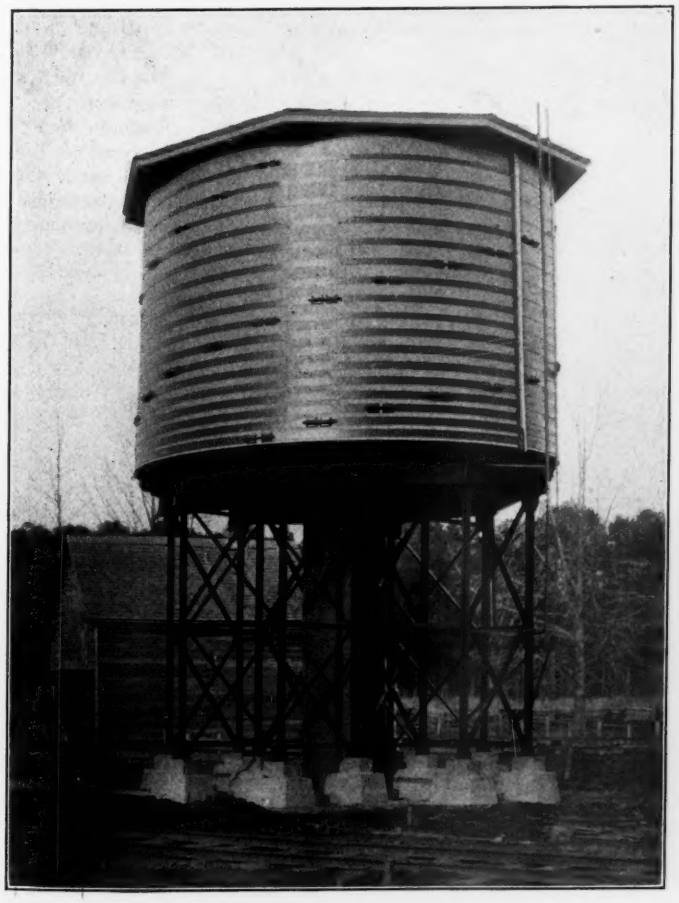


Condensed Profile from Goddard to Red Bay; Birmingham Line of the Illinois Central.



Overhead Crossing of Southern Railway near Corinth, Miss.; Mississippi & Alabama Railroad.

Brush Creek Viaduct, Showing Traveler.



Type of Water Station.

in front, 8 ft. wide, and a rear porch 6 ft. wide. Back of the dining room, and connected with the main portion of the house by a latticed porch, is a large kitchen. The second floor, or attic, is fitted up for sleeping rooms and is reached by a stairway from the hall. The interior furnishings are plain. The two living rooms each have an open fire-place finished in common ashlar and red sandstone.

Houses are also provided for section laborers, near the section foremen's houses. These laborers' houses are also story-and-a-half, with a front and back covered porch, each 6 ft. wide, extending the full length of the house. The two rooms are 16 ft. x 16 ft., but are not separated by a hall as in the section foremen's dwellings. The attic is reached by a stairway from the kitchen and is fitted up for sleeping rooms.

The type of water station used is shown in a photograph; it

Stephenson Hill Cut; Mississippi & Alabama Railroad.

Chub Hill Cut; Alabama Western Railroad.

is a 100,000-gal. tank with steel underframe on concrete footings. Those water stations located at points where there is a passing track have a penstock between the tracks.

The finished grade is 24 ft. wide in cuts and 18 ft. wide on fills. The theoretical side slope in cuts is 1 to 1, and on fills 1½ to 1. In the cuts are side ditches 4 ft. wide and 1 ft. deep. The track is laid with A. S. C. E. section, 85-lb. rail, and is ballasted with gravel, the ballast being obtained from pits located on the line. Passing tracks 3,200 ft. long are placed at intervals of about six miles.

Wherever possible, public highways are carried either over or under the tracks. In many instances it was necessary to buy extra

property on which to divert a highway, in order to eliminate a grade crossing.

To operate the line at the outset to the best advantage, terminal facilities have been provided at Corinth and Haleyville. These comprise a coaling station, water station, turntable and the necessary tracks.

Traffic arrangements with other companies provide that improvements be made on their respective lines which will enable the Illinois Central to operate from Jackson, Tenn., into Birmingham, 220 miles, by providing only a few additional facilities at Jackson, where it now has freight terminals, and by building complete freight terminals in Birmingham. The passenger trains will use the new union station along with all other roads now entering Birmingham. The freight terminals in Birmingham consist of a city yard, a freight house and a three-story storage warehouse equipped with electric freight elevators, on the property bounded by First and Second avenues, and Thirteenth and Sixteenth streets; also an outer yard at East Thomas. The city yard is convenient to the wholesale district, as well as being centrally located for the entire city business.

The storage warehouse at the corner of Sixteenth street and First avenue was formerly the Brewer building. It is 196 ft. 6 in. x 141 ft. and has been entirely remodeled. It is three stories high and equipped with electric freight elevators. In remodeling, it was divided into three sections, separated by fire walls. The entire top floors and two-thirds of the second floor are used for the storage of freight. One-third of the second floor is used for offices. Two of the yard tracks extend into the building on the ground floor. The ground floor space fronting on the alley between First and Second avenues is for inbound freight. A one-story addition, 342 ft. long and 30 ft. wide, has been built along First avenue. This addition, with the portion of the first floor of the original building facing First avenue, constitutes the outbound freight house.

The city yard connection is made with the 'Frisco System at Ninth avenue and Twelfth street, and required the construction of 2,800 ft. of double main track in Twelfth street from Ninth to Second avenues laid with 85-lb. rails. The yard contains 7,000 ft. of track. At First avenue and Twelfth street a single-track connection, 700 ft. long, is made with the Birmingham Southern. The outer yard, containing 47,000 ft. of track, connects with the Frisco at East Thomas, through which suburb a single track 1.95 miles long has been built.

Other terminal facilities are located adjacent to the outer yard; they comprise a 20-stall engine house, a machine and repair shop, a store-room and a joint office building for the operating and mechanical departments. These buildings are all of brick. There are also a 75-ft. turntable, two Illinois Central standard 125-ton coal pockets, two standard concrete cinder-pits, a 100,000-gal. water tank with steel underframe on concrete foundations, a 10-in. penstock, a pump-house and an oil house, and the necessary piping and fire protection.

The construction of the line was begun in February, 1906. The grading and track laying of the section in Mississippi was completed during October, 1907, and the Mississippi & Alabama Railroad was put in operation during December, 1907. The part in Alabama was put in operation February 1 of this year.

The line should have good traffic from the start. Birmingham is an important manufacturing center, the iron trade being its leading industry. The Alabama ores, because of the phosphorus and silicon they contain, are especially suited to the open-hearth process. The steel industry in Birmingham has grown to large proportions in the last 12 years. In the same period the manufacture of cotton goods has quadrupled. The resources of the country traversed by the new line include coal, timber and agricultural products, of which cotton is the most important.

Brush Creek Viaduct; View of Structure.

Among Austrian railroads, briquettes are used only by the State Railroads. They used, last year, 33,000 tons made at Pilsen, Bohemia, and 11,000 tons of English briquettes. The coal used during the same period amounted to 4,400,000 tons. The briquettes were of two sizes: one weighing 2.2 lbs. and the other 4.4 lbs., both kinds being oval. The price for the Bohemian briquettes was about $3.60 a ton and for the English briquettes, about $5.80.—*Consular Report.*

Combination Freight and Passenger Station and Division Offices; Corinth, Miss.

Russell Harding.

Russell Harding died in New York City on March 3, 1908, from complications following a surgical operation. He was an exceedingly able railroad man. His early railroad experience was largely on the Gould lines, to which he later returned as an executive, but his first great reputation was made under James J. Hill on the Great Northern, of which entire system he was made general superintendent two years and a half after going to the road as superintendent of the Dakota division. His rapid advancement on the Great Northern resulted in his return to the Gould lines which he had left as Superintendent and Division Engineer, as Vice-President and General Manager of the St. Louis Southwestern, an office which carries with it the presidency of the St. Louis Southwestern of Texas. In this capacity he proved himself a bright and capable executive officer and after about two years was called to be executive head of the Missouri Pacific system as Vice-President and General Manager, his authority later including the Denver & Rio Grande and the Rio Grande Western. It was on the Missouri Pacific that Mr. Harding made his most notable record. The road during the four years in which it was in his charge made great advances both in prosperity and in physical condition.

Mr. Harding was born on July 24, 1856, at Springfield, Mass. At the age of 14 he entered railroad construction service; three years later he was office boy and paymaster for his father, who was then a contractor on the Portland & Ogdensburg, a road part of which now belongs to the Maine Central, and the Vermont division of which belongs to the St. Johnsbury & Lake Champlain. In 1873, when he was 17, he went to Texas and worked for three years in the engineering department of the International & Great Northern. During the three years from 1877 to 1880 he was station agent, operator and ticket seller on the same road. In 1880 he was appointed Assistant Engineer of Construction of the International & Great Northern, and during the next six years was Engineer of Construction, Superintendent of Construction, and Resident Engineer in charge of tracks, bridges and buildings. In 1886 he was transferred to the Missouri Pacific as Superintendent and Division Engineer of the lines in southern Kansas, with headquarters at Wichita Falls, a post which he held for eight years.

Russell Harding.

Then he went to the Great Northern as Superintendent of the Dakota division, with headquarters at Grand Forks, N. Dak. Eighteen months later he was appointed General Superintendent of the Western district, with headquarters at Spokane, Wash., and 11 months after that General Superintendent of the whole Great Northern system. This position he held for a year and nine months. In the fall of 1898 he became the operating head of the St. Louis Southwestern, and on March 12, 1900, of the Missouri Pacific. In August, 1904, he left the Gould lines to take active charge of the "Great Central Route," made up of the Pere Marquette, the Cincinnati, Hamilton & Dayton, and the Chicago, Cincinnati & Louisville, being elected President of the first and Vice-President of the other two. When this system was bought by J. P. Morgan & Company for the benefit of the Erie Railroad, Mr. Harding was elected Vice-President of the Erie also, a position which he held for only a month, when the Erie retired from its purchase of these roads. In November, 1905, he left active railroad service to act as an adviser of H. B. Hollins & Company, bankers, of New York, to whom his extensive and successful experience proved to be of great value. He was associated with this firm up to the time of his death.

Mr. Harding had both ability and an attractive personality. In his business life he was courteous and kind; by his employees he was beloved, and to the lowest of them he was accessible. The men on the Missouri Pacific, with whom and over whom he worked, he regarded almost as his children. One of his strong points as a railroad officer was the fact that during his whole career there was harmony between him and his employees. His gracious manner and courtly dignity were bound up with a kind heart.

His genial character was shown to best advantage in his home life. He and his wife, who survives him, were an unusually congenial and loving couple. He was also a devoted son. His loyalty and affection to his mother were outwardly evidenced during her lifetime by the fact that a week never passed without his writing to her.

His remains were taken to Portland, Me., and laid beside those of his father and mother at a point chosen by himself on the slope of a hill overlooking the railroad.

Corporate Management Versus Government Control.*

My experience in the conduct of independent and impartial examinations of books of account and affairs has covered many years and has been concerned with the federal government, state governments and city governments. It has covered the field also of railroad, street railway, light, power and other public service corporations. It has dealt with industrial corporations, the so-called "trusts." It has taken me into banks, trust companies and insurance companies; into educational and charitable institutions. I think I may say it has taken me pretty generally over the whole field of public and private business, and if I am to judge by what my eyes have seen, it is the unassailable truth that almost any one of the men who stand at the head of our great business institutions is far more competent to run the government, and would run it more economically, more wisely, and more honestly than any of those who are in the business of running governments.

I know as a matter of fact that the management of our great properties is generally intelligent and economical, and that the management of our government bureaus is generally loose, irregular and frequently dishonest; and when I read the articles with which so many of our newspapers and magazines are filled nowadays, reflecting on the men whose genius is developing the country's resources, and when I hear the proposals of politicians, from the most eminent to the least, for the passage of laws to hamper and restrict the energies of these men on the theory that their integrity is open to suspicion, my mind inevitably brings up the contrast that I always observe between a corporation's way of doing things and a government's, as disclosed by their respective records and books of account.

For the purpose of this comparison, incompetency and dishonesty need not be separated. Putting them together it is my deliberate estimate, that, judged by the highest standards prevailing in the best conducted corporations, there is less than 10 per cent. of both among men in the management of corporations generally, and at least 90 per cent. of both among public office holders, and I base this estimate upon my experience as a public accountant.

The men entrusted with the management of the corporations are better fitted to administer the affairs of such corporations and to exercise judgment in matters concerning both the investor and the public which takes their product or utilizes their franchises, than are those men who hold public office qualified to fill even their own positions, much less to undertake administrative control over corporations. The facts that prove this do not deal with the mere matter of honesty and efficiency. The organization of a public bureau is much less compact, much less harmonious in its operation than the organization of a great railroad or a great industrial corporation. The men at the head of such business organizations, in practically every case, are experts, working diligently, in harmony, and ready to work to the limit of their endurance, with full and direct control of their subordinates. On the other hand, nothing can be more notorious (the results are obvious to every public accountant who investigates) than the fact that in nine cases out of 10 the

*From an address by Elijah W. Sells, C. P. A., before the Certified Public Accountants of New Jersey.

head of a public department spends most of his time promoting his political interests, and the employees generally, protected by the civil service regulations, are looking to see how little rather than how much work they can get into their appointed short hours.

Curve Superelevation.

BY M. L. BYERS,
Chief Engineer, Maintenance-of-Way, Missouri Pacific Railway.

The constantly increasing speed of trains, together with the radical change in the height of the center of gravity of the locomotive, due principally to the introduction of the wide firebox, has caused the subject of superelevation of curves to assume greater importance than was formerly the case.

The usual basis for determining the amount of superelevation is a formula in which the factors are the radius of the curve and the speed of the train. If it were possible to regulate the speed of trains so that all passed around the curve at the same speed, this formula might be practically satisfactory; on the contrary, however, it is always necessary to make the superelevation a compromise between the speed requirements of various trains. If the curve is prepared to exactly suit the speed of the fastest train, such as the limited mail train when it is several hours late, then difficulty is experienced in connection with the operation of the slow freight trains. If, on the contrary, the curve is elevated to suit the speed of the slow freight trains, then the track may be absolutely dangerous for unrestricted high-speed traffic and it may be necessary to place restrictions on the speed at which the curve can be used. It becomes important, therefore, to determine the limitations of safe operation and also to understand the practical effects on curved track of the various forces encountered in connection with train operation thereon.

Some years ago Mr. J. C. Bland, Engineer of Bridges, of the Pennsylvania Lines West of Pittsburgh, proposed to apply to the solution of the problem of superelevation of curves the fundamental principle employed in the design of masonry structures, namely, that the resultant of all of the forces must, for safety, lie within the middle third of the structure. Translating this into terms of track conditions, it means that the resultant of the centrifugal force and the weight of the locomotive (or car) must fall within the middle third of the space between the two rails of the track, the proper speed for a given elevation, or the proper elevation for a given speed being that which will cause the resultant to fall in the center of the track. From these assumptions we may derive formulae as follows:

Let G = Gage of track in feet (assumed in tables as = 4 ft. 9 in.).
E = Superelevation of outer rail in feet.
E_1 = Superelevation of outer rail in inches.
V = Velocity of train in feet per second.
V_1 = Velocity of train in miles per hour.
F = Centrifugal force in pounds.
W = Weight of locomotive in pounds.
R = Radius of curve in feet.
H = Height of center of gravity of locomotive in feet.

Proper Speeds and Elevations.

Construct Fig. 1 so that *df* shall represent the gage of the track G, *fe* the superelevation E; *bc* the horizontal line from the middle point *c* of the line *df* will represent the centrifugal force F, and the perpendicular *ab* the weight W of the locomotive, such that the resultant shall be perpendicular to the track and shall pass through the center point *c*.

In the similar right triangles *abc* and *def*, we have

$$ab : bc :: de\ (= df, \text{ approx.}) : ef,$$

or $W : F :: G : E$

$$\text{or } E = F\,\frac{G}{W}$$

$$\text{but } F = \frac{W}{32\,{}^1\!/_6} \times \frac{V^2}{R}\ (= \text{Centrifugal force}).$$

Substituting, we have

$$E = \frac{W}{32\,{}^1\!/_6} \times \frac{V^2}{R} \times \frac{G}{W} = V^2\,\frac{G}{32\,{}^1\!/_6\,R}$$

$$\text{or } V^2 = 32\,{}^1\!/_6\,R\,\frac{E}{G}$$

$$\text{or } V_1^2 = 1.2\,R\,\frac{E_1}{G} = R\,\frac{E_1}{4} \quad \text{when } G = 4.75$$

$$V_1 = \sqrt{R\,\frac{E_1}{4}} = \text{Proper speed for a given elevation and curvature} \ldots\ldots\ldots\ldots\ldots\ldots (A)$$

$$E_1 = \frac{4\,V_1^2}{R} = \text{Proper elevation for a given speed and curvature} \ldots\ldots\ldots\ldots\ldots\ldots (B)$$

Maximum Safe Speed.

In Fig. 2, lay off the horizontal line *al*, and from any point *b* lay off *be* so that *be* shall represent the gage of the track and the perpendicular *em* to the line *al* shall represent the superelevation of the outer rail. From *c*, the center line of the track, erect a perpendicular to *be* such that *cd* shall represent the distance from the top of rail to the center of gravity of the locomotive, the point *d* representing such center of gravity.

Lay off on *be* the point *f* such that it shall lie on the middle third of the track and, consequently, that $cf = \frac{1}{6}$ gage of track $= \frac{G}{6}$.

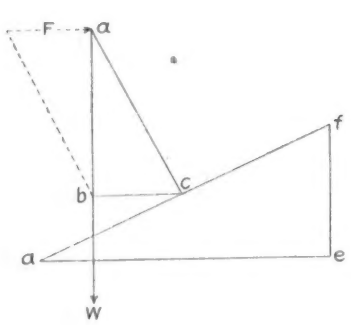


Fig. 1.

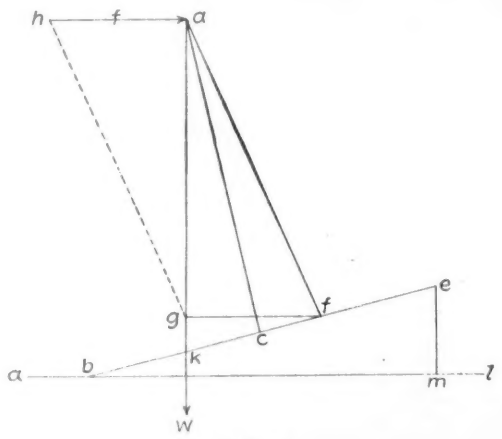


Fig. 2.

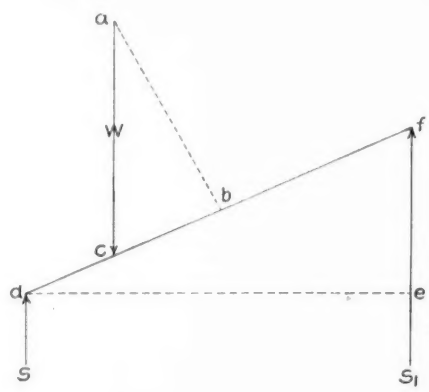


Fig. 3.

Draw *df*, and draw *fg*, a horizontal line intersecting at *g* the vertical line *dg* let fall from *d*.

Draw *gh* parallel to *df*.

If *dg* represents the force of gravity W, equal to the weight of the locomotive, acting through its center of gravity *d*, then will *dh* represent the centrifugal force F, acting also through the center of gravity *d*, of the locomotive, such that the resultant of these two forces shall pass through the point *f* on the edge of the middle third of the track, and being the maximum safe centrifugal force under the conditions.

As it does not involve a material error, we will assume that

$$be = bm\ (= G)$$
$$cd = kd\ (= H)$$
$$fg = fk.$$

In the similar right triangles *bme* and *dck*

$$bm : em :: cd : ck$$

$$G : E :: H : ck, \text{ or } ck = H\,\frac{E}{G}.$$

As $cf = \frac{G}{6}$, we have

$$kf\ (= fg) = ck + cf = H\,\frac{E}{G} + \frac{G}{6} \ldots\ldots\ldots\ldots (1)$$

In the similar triangles *bme* and *fgk*,

$$be : em :: fk : kg$$

$$G : E :: \left(H\,\frac{E}{G} + \frac{G}{6}\right) : kg$$

$$\text{or } kg = E\,\frac{\left(H\,\frac{E}{G} + \frac{G}{6}\right)}{G}$$

$$dg = dk - kg.$$

Substituting for *dk* its value H and for *kg* its value in (1)

$$\text{we have } dg = H - E\,\frac{\left(H\,\frac{E}{G} + \frac{G}{6}\right)}{G} = H - \frac{E}{G}\left(H\,\frac{E}{G} + \frac{G}{6}\right). \ldots (2)$$

If, in the right triangle *dgf*, we represent *dg* as equal to W,

the weight of the locomotive, and *fg* as F, the maximum allowable centrifugal force, we have

$$dg : gf :: W : F$$

$$\text{or, } F = W\frac{gf}{dg} \quad \ldots\ldots\ldots\

that usually required to keep inside the middle third the resultant of all the forces for the fast moving train.

Wheel Flange Mounting Rail.

Fig. 5 shows the relative position of the wheel and rail when the flange is crowding the side of the rail. It is evident that one effect of centrifugal force exerted on the wheel will be to cause it to rise and that sufficient pressure would enable the wheel to mount the rail.

As the force F is resisted by the normal to the line *ad*, the vertical component resulting must equal W, the weight of the wheel, before the wheel can rise; this condition will result under the following relation:

$$F : W :: ab : bc$$

$$F = W \frac{ab}{bc}$$

but, in practice, $ab = 2bc$,
which gives $F = 2W$.

But, $F = W \dfrac{V^2}{32\frac{1}{6}R}$

Substituting, $2W = W \dfrac{V^2}{32\frac{1}{6}R}$

or $V^2 = 64\frac{1}{3}\ R$

$$V = 8\sqrt{R} \text{ approx. or } V_1 = 12\sqrt{R}$$

For a 6° curve, $V^1 = 12\sqrt{955} = 360$ miles per hour approximately.

Evidently under ordinary conditions there is no danger of accident on this score; however, where an engine is improperly counterbalanced and running at high speed it is known that at times there is almost no pressure exerted by the wheel on the rail and it would seem possible that, under these conditions, a case might arise where the wheel will be lifted up and forced over the rail by the centrifugal force.

General Remarks.

All formulas in regard to the proper superelevation and safe speed for curved track are more or less open to the criticism that they are far more accurate theoretically than the data upon which their practical use is based.

All track, and especially curved track, requires more or less constant attention in order to preserve a reasonable degree of accuracy of line and surface. Inasmuch as any deviation from the true circular curve means a sharper resultant curve, errors in alinement produce the same effect as the uneven superelevation of a circular curve, and conversely, errors in uniform superelevation of a circular curve produce the effect of the curve being out of line.

When curves are not spiraled it is necessary to commence the superelevation on the straight line some distance in advance of the point of the curve, a very general practice being to place one-half of the run-off on the straight line and one-half on the curve. The result of this practice may be illustrated as follows:

Assume a curve with 6 in. of elevation, then the elevation at the point of curve will be 3 in.; just before reaching the point of curve the effect produced is that of encountering on a straight line a spot where one rail has become 3 in. out of surface; this would be regarded as a dangerous condition inasmuch as it tends to overturn the locomotive in the direction of the low rail; immediately upon passing beyond the point of curve on to the curve, the condition of a curve with but one-half of the proper superelevation is encountered and the tendency, of course, is toward overturning the locomotive in the direction of the high rail. Naturally, perfect results cannot be obtained under this condition and it has become the general practice to spiral all sharp curves.

It is known from shop tests of locomotives that, with some engines at high speeds, due to imperfect counterbalancing, there are times in the revolution of the driving wheel where there is absolutely no pressure on the rail from that wheel, the pressure having been transferred to the opposite driver which carries an abnormal load for the instant; this, of course, introduces a new factor in determining the resultant of the various forces at work on curved track and with a locomotive running at a speed higher than that corresponding to the elevation of the curve serious results might in some case be produced.

The long rigid wheel base of some locomotives has, of course, the effect of considerably increasing the pressure of the flange against the head of the rail.

General Conclusions.

1. It is undesirable to use a greater superelevation than that which will permit any locomotive to stop with safety on the curve.
2. Curve tables which state, not only the proper elevation for a given speed, but also the safe maximum speed for a given elevation for the locomotive with the highest center of gravity in use on the railroad, should be used.
3. All curves should be given such superelevation as will make them safe for the maximum speed at which a late train will be apt to use them, or special instructions restricting the speed should be placed on the time cards.
4. All curves of 1 deg. or over and used by trains at high speed should be spiraled and the change from zero to maximum superelevation should occupy the limits of the spiral.
5. The ill effect of high center of gravity, long wheel base, and inadequate counterbalancing of locomotives, should be kept in mind with a view to minimizing their undesirable results on the track.
6. As the superelevation selected is usually a compromise between opposing speed conditions, the extent of the variation of the extreme conditions from the compromise should be kept in mind and the character of the track regulated accordingly.

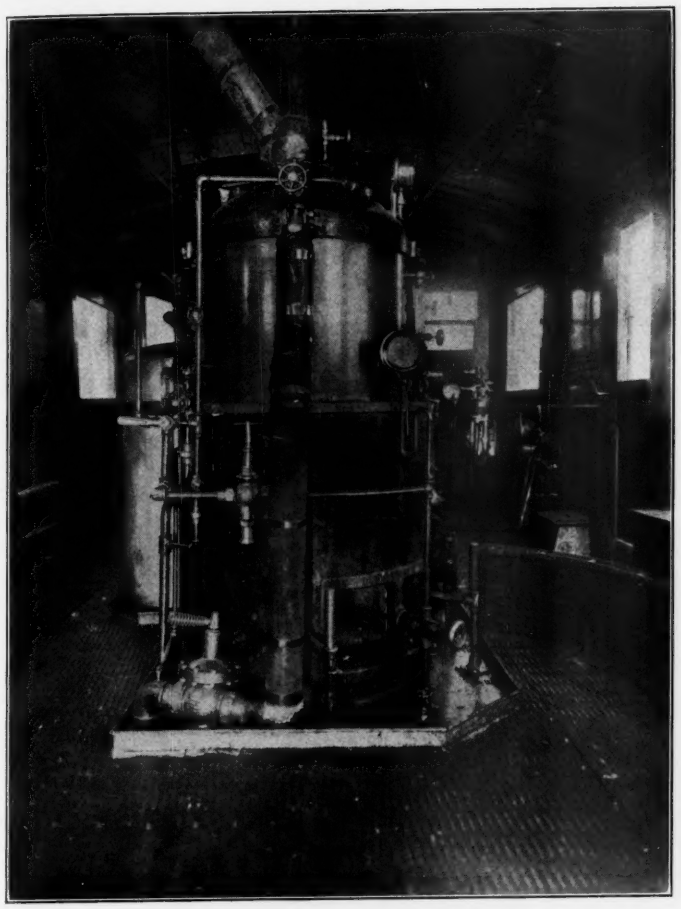
Train Heating on Electric Divisions of Steam Railroads.

BY CHARLES M. RIPLEY.

The establishment of great passenger terminals in New York City, involving extensive tunnel systems and other improvements, looking not alone to the more economical and expeditious handling of traffic, but also (and in a measure primarily) to the minimizing of accidents due to the obscuration of signals by reason of smoke in the tunnels, has led to the employment of electric traction within the terminal stations and for a distance of several miles along the right of way. The adoption of electric traction at once gave rise to the problem: How shall the passenger coaches be heated after the steam locomotive is supplanted by the electric locomotive which is to haul the incoming train a distance of several miles, and, conversely, must haul the outgoing train an equal distance before it can depend upon steam from the steam locomotive to heat its coaches?

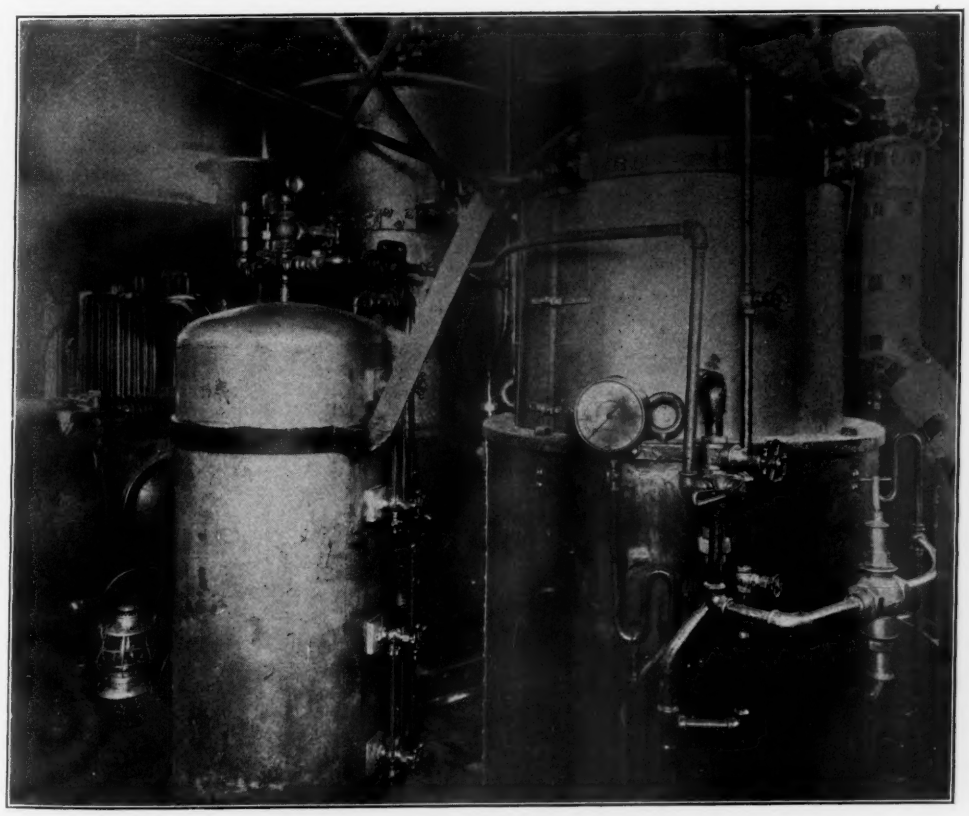
In the solution of this problem economy as well as efficiency must be studied. To install obsolete stoves for temporary use in the individual coaches, a method of heating as ineffective as it is fraught

Location of Heating Apparatus in New Haven Electric Locomotive.



End View of Heating Apparatus.

with danger, was not to be thought of. To heat the cars by electricity, while perfectly feasible, involves not only the expense of equipping every coach with electric heating apparatus, in addition to the steam pipes which would be in use during the major portion of the run, but also involves the considerable loss of efficiency always accompanying heating by electricity.



Side View of Heating Apparatus.

The mechanical engineer has been called in to give assistance to the electrical engineer in this heating problem, and there have been devised two methods now in successful operation; one adapted to the rolling stock of the New York Central and the other to that of the New Haven.

So far as these methods are identical, they may be briefly described as follows:

In the electric locomotive is installed a vertical boiler, which, as soon as the steam locomotive is unhooked and replaced by the electric motor, is connected to the regular piping system of the train. Thus, with virtually no interruption steam heat is supplied to the coaches, regardless of the change in the mode of traction, without necessitating any addition to the regular heating apparatus of the coaches. The fuel for this boiler is ordinary commercial fuel oil.

The photograph shown herewith was taken in the inside of one of the New York Central electric locomotives, and shows the oil-fired auxiliary steam boiler now used in heating trains on the electric division. The apparatus consists of a multi-tubular boiler mounted on a cast iron firebox lined with brick. The boiler has 800 copper tubes ½ in. in diameter and fitted with steam and water gages, try cocks, safety valve set to 80 lbs., blow-off connection and automatic feed-water regulator.

Water and oil are carried in two steel tanks under pressure. The pressure of the water is 135 lbs. per square inch, which is sufficient to supply the boiler without employing a feed pump. The oil is stored at a pressure of 25 lbs. per square inch. The air for supplying this pressure is taken from the main reservoir in the locomotive air-brake apparatus and is reduced to feed the oil tank by means of a regulating valve.

The water tank is of 200 gal. capacity and is filled by attaching a hose on either side of the locomotive and opening the vent valve on the top of the tank. The water is then forced up into the tank by the pressure on the mains. Try cocks are fitted to test the height of the water in the tank. The oil tank, which is 40 gals. capacity, is fitted with two glass gages to enable the operator to ascertain the amount of oil contained.

Water is led to the boiler through an air trap. In the photograph the screen is shown thrown back to better show the apparatus under the boiler. The Kirkwood oil-burning system manufactured by Tate, Jones & Co., Inc., of Pittsburgh, Pa., which supplies the fuel for the boiler, is arranged to use either air or steam to atomize the oil. The change is made from one to the other by means of a three-way cock. Air is used to start the fire and steam when boiler pressure is reached.

The main difficulty in connection with oil as a fuel is to obtain complete combustion of the ordinary commercial fuel oil. In order to obtain this complete combustion of such oil it must first be completely atomized. To atomize each gallon of oil there is required approximately 60 cu. ft. of free air at a pressure of 15 to 25 lbs. per square inch. There must then be supplied by one or the other of two means, approximately, 1,440 cu. ft. more to give sufficient oxygen to the flame.

The New York Central apparatus is arranged to allow considerable space around the nozzle of the Kirkwood burner, through which air from the surrounding atmosphere is drawn into the combustion chamber by the force of the injected atomized oil. This method of drawing in the 1,440 cu. ft. of air has been known to result in a noisy burner at times, and it has been open to the objection that it is difficult to control the amount of air drawn in. It is also obvious that the use of a greater amount of compressed air than is necessary for atomizing is required in order to draw in a sufficient amount of the surrounding air. This method makes up with compressed air any deficiency in the quantity of surrounding air drawn in. A decided advantage, however, in this method is that it makes unnecessary the expense of installing any extra blowing apparatus and drive for same, both of which take up considerable room in the rather confined space of the electric locomotive.

The electric system of the New Haven road is rather unique in the field of American electric traction, inasmuch as transformers are used in the locomotive to reduce the voltage of the alternating current supplied. The advisability of cooling these transformers by air needs no comment; an air-blast apparatus has been used both to cool the transformers and to assist in burning the oil. The accompanying drawing illustrates a New Haven electric locomotive, in which a Kirkwood oil burner is installed. A low-pressure fan blast at from 3 to 4 oz. pressure is used for blowing into the combustion chamber the necessary air for combustion. Thus compressed air is needed only for atomizing the oil.

This scheme cuts down the amount of compressed air used and

increases the efficiency of the fire. It enables the operator or fireman to completely control the nature of the fire by varying the quantity and pressure of the air-pressure blast for combustion. The oil and compressed air for atomizing is regulated by one lever, and the ratio between the oil and the compressed air for atomizing always remains at a constant point, which has been found to be the best for complete atomization. The fireman or operator cannot make an inefficient or smoky fire, the regulation of the air blast varying only the nature of. the fire from a soft and non-oxydizing flame to a hot concentrating fire.

Both the New York Central and the New York, New Haven & Hartford railroad heating systems are simple to operate, and no extra men are required in the cab to operate them, this work being part of the duty of the fireman.

Ocean Carrier.

BY J. RUSSELL SMITH, PH.D.

X.

LINE TRAFFIC IN THE UNITED STATES COASTING TRADE.

The United States coasting trade has always been composed of two elements and the line traffic in its service has been the sport of at least two circumstances.

The two elements of the coasting trade are, first, the local exchanges between the various parts of the United States, which are ever growing; and second, the collection of produce at convenient places for export, and the distribution of imports from greater to lesser ports. This foreign trade factor is an uncertain one, having fluctuated greatly from time to time in our history. This fluctuation arises, and with it the changes in line traffic, from the differing degree of development of our line traffic from the various American ports to foreign ports. If there are many ports on an equality of foreign connection there is little need for collection and distribution among them in connection with the foreign trade. If some ports have a great predominance in foreign line connections the coasting trade will center at such ports and develop largely.

The second factor that has influenced the line traffic, has been the growth of the American railroad system. At one time the coasting vessel was almost the only means of getting from port to port. Then came the railroad which took away from the coasting vessel all possible claim to being a fast line connecting the various parts of the United States. This left the coasting lines only such traffic as they could snatch from the competition of the speedy railroads above and from the slower and cheaper schooner and latterly the yet cheaper barge below.

In its origin, coasting line traffic is closely akin to the ocean line traffic as was pointed out in the article on the "Origin of Line Traffic." In the Colonial time the coasting trade was light and with the small vessels of that day each colony traded direct with the mother country, more directly, indeed, than do many of the American commonwealths at present. In the era between the Revolution and the War of 1812, the same conditions prevailed and one port was almost as good as another. This was the period of greatest democracy among American seaports. New Orleans, Charleston, Savannah, Baltimore, Philadelphia, New York, Boston and Salem were more nearly on an equality than they ever have been since. The difference in their population was surprisingly small. Each had that breadth of sea connection which the enterprise of her merchants brought; and it was a wide range, as these cities, with the exception of Salem, were the metropoli of states which in the days of the confederation were not only politically independent, but also commercially independent and isolate except for the merchant ship that roved alike to foreign and to coasting ports.

The close of the war of 1812 changed all this. New York straightway, upon the declaration of peace in December, 1815, became the center of packet lines to Europe, especially Liverpool the great market for cotton and other American produce. By 1820, these lines had multiplied until there was a weekly sailing on regular schedule and the ships were the fastest on any sea. These New York packets carrying mail, passengers and fast freight straightway put into our coasting trade the stimulus for regularity that ripens into line traffic. If the New York packet left regularly it was an advantage to reach New York just before she started, and it was desirable to get the European mail and passengers and goods started down the coast at regular intervals so the New York lines were really the mother of the coasting line services that sprung up promptly upon its inception.

The New York foreign connections had an influence not measured solely by the founding of coasting lines, for they served also as a magnet to draw to New York the chartered vessels from the South Atlantic ports. This influence was not alone in producing this result, for the claim was also advanced that the New York merchant gave better credits and other inducements than were to be obtained further south. Transportation, however, was no weak force in this drawing influence, and the decade 1821-31, the ten years following the establishment of New York's weekly service to Liverpool, saw a marked shifting of foreign trade. The country at large and particularly the south was prosperous. The foreign trade of the port of New York increased 100 per cent. in eleven years following 1821, and that of Virginia with its tidal estuaries declined two-thirds, and so did that of South Carolina. This, however, did not mean a declining commerce, despite the alarm and the investigations by commission and convention. It was merely a growth in the coasting trade by which New York absorbed the foreign trade of smaller ports that had dealt directly with Europe in the epoch of the merchant carrier 20 years before.

New Orleans was far enough away not to be so greatly influenced by New York's maelstrom and retained her commercial independence all through the packet ship epoch and practically down to the Civil War. The gulf packet lines went to New Orleans, as did those of the Atlantic to New York and to a lesser degree to Boston. Until 1860 Galveston traded entirely through New Orleans, and the connection of New York and New Orleans was rather slow in founding. The reasons of this were that New Orleans was rather independent of New York in the foreign trade, and New York was rather independent of New Orleans in the coasting trade through her ability to secure cotton, lumber, meat and grain and naval stores at nearer ports.

From 1820 to 1840 there was a large development of coasting packet lines along the American coast from Portland, Maine, to New Orleans. The earliest of these lines appears to have been in 1820 from New York to the southern ports. Baltimore had had a line to Norfolk as early as 1785, but this can scarcely be called a coasting line because it was entirely on inland waters. In 1826 Baltimore had its first regular service by sea, a line to Savannah and New Orleans.*

Upon the founding of steam connection between New York and Savannah in 1848 there were six packet lines connecting these two ports.†

The difficulties of sail navigation on such a windy, stormy and dangerous coast as that of the American Atlantic made the line service of packets, at best, but irregular and undependable. Efforts were early made to put steamers in the coasting service, but the steamer in its origin was a river craft and its first successes in giving that line traffic with a schedule having an arriving as well as a departing end, was in that part of our shore waters which partly resembles a river and which is also adjacent to the Hudson, the original home of the steamboat.

Long Island sound, being a kind of compromise, half sea, half bay, was a good place for the steamer to experiment with line traffic on salt water. In its traffic development, Long Island sound was a sort of offshoot from the Hudson river, the first home of the steamer. For at least 40 years the same boats were used interchangeably on the two bodies of water. During the war of 1812, boats built for the Long Island route to New Haven were unable for fear of the enemy to run on the sound and were put on the Hudson in 1814. In March, 1818, the two steamers built for the sound began a service from New York to Norwich, the steamers connecting with each other at New Haven, one attending to each end of the route. In 1822 they were withdrawn from the New York, New Haven and New London route, because of the retaliatory law of Connecticut against the New York steamboat monopoly of Fulton, and sent instead to Providence and Newport. This action of the New York and Rhode Island Steamboat Co. was regarded as hazardous in the extreme, because of the dangers of going into the open sea to round Point Judith. The venture was a success, and the forbidden Connecticut traffic was picked up at Long Island points whither it was taken in connecting sailing packets. The Providence line kept on, and the two trips each way per week in 1822 were changed to four trips per week in 1825. In November, 1821, the New Haven Steamboat Company was organized by the shareholders of the packet company running between New York and New Haven and steamers were put on the route.

The efforts of sailing vessel owners to get a tax laid upon steamboat passengers failed in the sound states, but a new line to Providence in 1827 was a more serious blow to the finances of the pioneer company, because it cut the fare down from $10 to $6. In 1831 it was cut to $4, then to $3, but the next year it was $7 by each line.

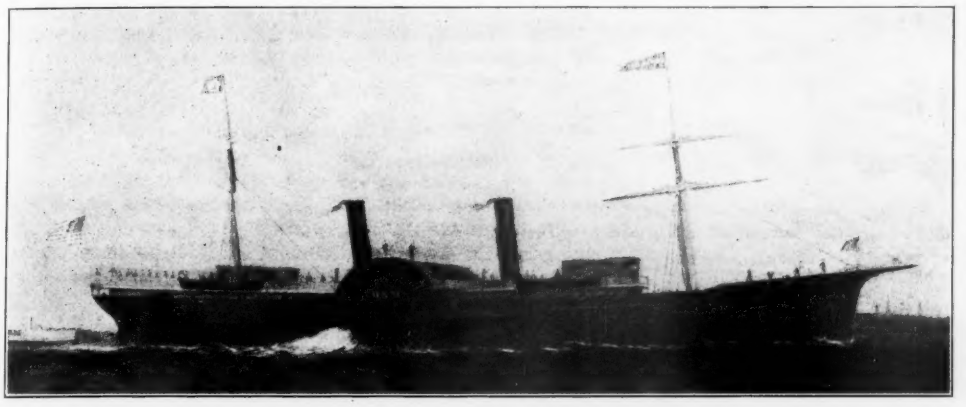
By this time, line traffic by steamers was well established on the sound, and it has continued from that day to this. In 1835, when the railroad connecting Providence and Boston was completed, the sound steamers established schedule connections which were as good as those of the trains with which they connected, and such connection by high-class steamers has been continuous, although there are freight lines having no such scrupulous schedule connection with the railroads.

The thorough and efficient line organization of the steamers on Long Island sound in 1830 was far different from the situation on those routes that had to stand the full fury of the Atlantic.

*"Chronicles of Baltimore," J. T. Scharff, p. 420.

†Morrison's history "American Steam Navigation," p. 448.

The 20 years 1818-1838 were a time during which the steamer was evolving from a river craft to a sea craft and the short journeys along the Atlantic coast tempted men to try the coasting trade before the ship was ripe for it. For five years beginning in 1820 the steamer "Robert Fulton" plied unprofitably on the route from New York to New Orleans via Charleston and Havana. At the end of this time she was converted into a sailer. Between 1836 and 1839 steamers were run from New York to Charleston and from Baltimore to Savannah, and another attempt was made on the route to New Orleans. Two terrible disasters, coming in the midst of the great financial depression, caused all these attempts to be given up by 1839; and just at the time the Cunard and other companies were succeeding with their steamer lines on the Atlantic, the coasting lines in the open sea came again to consist entirely of sailing packets. In 1842, there was no steam coasting line outside of protected shore waters, but the North Atlantic steam lines



The Quaker City, 1854; 1,143 Tons. Regular Line to Charleston.

with their previously unknown precision made louder the demand for relief from the uncertainties of packet, and 1846 was the real beginning of steam service and therefore of regular line service between New York and Charleston. Spofford & Tiletson, shipping merchants of New York, contracted to carry the United States mail, and despatched the first steamer in September. In 1848 there were similar steam mail contracts to Savannah and New Orleans. The service to Norfolk, which had been tried and given up in 1835, was permanently established in 1844 by the founding of the Clyde Line to Baltimore. Richmond was connected with New York in 1835 and Boston with Philadelphia in 1852. For ten years, beginning 1850, Philadelphia was actively connected with New York by the outside route.

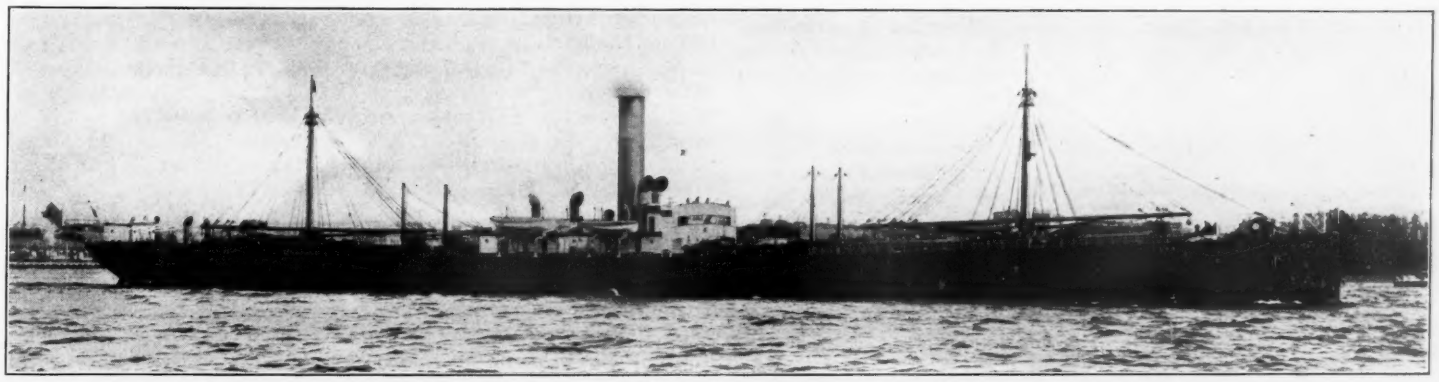
The route affording the most excitement during this period was that to the Isthmus of Panama. The gold rush of 1849 made plenty of travel in that direction and put a high price upon transportation in that direction. Lively competition ensued for the prize, sometimes the vessels stopped at Charleston or Havana or New Orleans, or all three, or none of them. Sometimes there was one line, sometimes there were several. The keenest competition was that between the Pacific Mail and the United States Mail Company, whose rivalry wound up in a consolidation in 1850 of the service to Chagres in the hands of the United States Mail Company.

In March, 1852,† there plied from New York seven lines of coasting steamers, one to Philadelphia, two to Norfolk, two to Charleston, one to Savannah and one to New Orleans via Havana. There were no less than ten diligent advertisers of lines to the Isthmus of Panama making connection for the Pacific at Chagres or San Juan de Nicaragua. Some of these lines had only one steamer, and during this month of March, 1852, a total of 20 steamers left New York in the San Francisco trade; while 30 departed on the seven lines of the coasting trade, Charleston being the destination of nearly one-third of the 30,000 gross tons involved. The height of the San Francisco rush was probably in February, 1849, before the isthmian routes were in full operation; during that month 22 sailing vessels left New York for California with 2,000 passengers. There were ten from Boston and other ports in proportion.

The date 1850 may be taken as marking the firm establishment of steamer lines on the transatlantic service, and it also marks their thorough establishment and extension in the coasting trade. In this work perfection followed quick upon the heels of installation, for the fifties mark the period of highest relative development of the coasting trade. The Collins and Cunard liners raced across the Atlantic to and from New York, and the wealthy, luxurious southerners had no such service from their own ports to Europe. They must connect with New York, but the railroads were in that day a poor dependence for they were new, rough and bad, breakdowns were common, changes were frequent, sleeping cars were practically unknown. What roads there were in the south commonly connected the interior with the nearest port rather than with the North. Hence the traveler who could sought the coasting steamer to New York whether he were bound to Europe or only to the northern states. The coasting steamers that went to Charleston and Savannah were next only to the Collins line in comfort and luxury, and they were as fast as the coasting lines have ever been until very recently. Their passenger traffic was extensive.

The Civil War, of course, entirely demoralized the trade and transportation with the south for a time. During a few years succeeding the war, however, the lines resumed their antebellum importance. The railroads were still inadequate and the passengers still sought the steamer. At the same time there was general prosperity and a great traffic movement that brought shipping profits and led to the creation of many lines. There were in March, 1872, 23 deep water lines in the place of the seven lines in 1852 at New York, besides smaller lines and sound and river boats. During this month these lines despatched 117 steamers with about four times the tonnage total of 1852. The average tonnage was almost exactly 1,000 tons per vessel.

The predominance of New York in the transatlantic line traffic and consequently in the coasting lines caused it to become quite largely the clearing house for the coasting trade. Go to New York and transfer was the easiest way. From the Civil War onward that city had steam connection with the coast of Maine at Portland, with the leading gulf ports, and with the chief ports between. In 1859, the Boston Chamber of Commerce tried to improve the



Steamer Texan. The American-Hawaiian Line Connects New York and San Francisco via the Tehuantepec Railroad.

connections of its port, because the only way from Boston to points below Baltimore was by sailing vessel direct or by transshipment at New York. In 1854 the Merchants & Miners' Transportation Company, a combination of Maryland and Massachusetts capital, had started service which connected Baltimore with Boston without making a New York stop, and the agitation of commercial interests in Boston in 1859 had the service which also included Providence, extended to Savannah in addition to the two Chesapeake ports of Baltimore and Norfolk. Excepting the interruptions due to the war, this service has been steadily maintained, and is one of the few important services that does not touch New York, and the only one that steams regardlessly past that port. The other services on a par with this have been the Boston services to Maine and the Canadian Maritime Provinces and the Philadelphia lines to Savannah and Florida points, but these Philadelphia lines have not been steadily maintained.

†*Railroad Gazette*, Aug. 15, 1902, p. 638. An excellent and thorough article by Ray Morris, to which the author is much indebted.

The decade following 1873 marks an epoch in the coasting line traffic. The country then suffered from general hard times with the accompaniment of reduced traffic, loss of dividends, failures, reorganizations, consolidations and forced economies. For the coasting lines, this was accentuated by the development of the railroads into effective competition for through passengers, mail and fast freight. This loss threw the coasters into a distinctly secondary position. They could not compete with the railroad in these respects, and it was recognized as being of no use to try, so the speed did not increase. Greater efficiency was sought in a larger and more economical vessel. The passenger traffic had changed from the general body of travelers to those persons who, for special reasons, wanted a slow sea journey. This brought about a considerable summer traffic and a negligible winter traffic.

These changes in conditions recorded themselves in the statistics of the traffic. In March, 1882, the 23 New York lines of 1872 had become 14, the 117 clearances had become 109, but the average size of steamer had increased about 50 per cent. During this period, also, the railroads which had dealt such competition, also began to annex the steamer lines, the best examples of this being the Morgan Line to New Orleans and the Savannah Line. Ten years later, these were the most efficient lines on the coast.

From 1880 to the present there have been surprisingly few changes in the coasting line traffic, other than in its increase in quantity. The departures from New York in the month of March have been approximately as follows: 1872, 120,000 tons gross; 1882, 160,000; 1892, 280,000; 1902, 410,000. In 1872 Boston led by being the destination for over a sixth, with Norfolk and Charleston closely following. In 1882 Norfolk had a fourth with Boston and Charleston considerably in the rear. Ten years later Norfolk was still first with more than a fifth, and Savannah and New Orleans following. In 1902, Norfolk led with a fifth of the whole, with New Orleans and Boston pushing it for first, and crowding each other for second place.

This growth of tonnage is essentially for the freight service, as passengers and speed have been steadily declining in the manager's mind, since the loss to the railroads of the mail service that occurred 30 years ago. Exceptions to this should be made for the Morgan Line (Southern Pacific), which connects New Orleans with New York in five days, and is a link in a transcontinental route, and also of the passenger service of the Old Dominion Line to Norfolk and the much advertised passenger line to Maine through Long Island sound. The extensively patronized passenger boats of the Long Island sound routes are not included in the above cited figures of New York traffic which are for deep sea vessels only.

Mention should also be made of the regular services that have been maintained throughout nearly the whole of the last hundred years between New York and Philadelphia by sea, and between Philadelphia and Baltimore via the canals during the season of open navigation. The Chesapeake bay with lines connecting Norfolk with Baltimore and Washington is in the class with the Hudson river in respect to earliness of the development of lines, the frequency of service and the type of steamer used.

The years 1906 and 1907,* following a long period of quiescence, were a time of interest and excitement in coasting trade circles. At the beginning of 1907 Boston had seven coastwise companies with lines to ten American ports between Eastport and Jacksonville. New York had 12 companies with lines to 19 ports between Portland and Galveston. Philadelphia had five companies with lines to eight ports from Boston to Savannah. Baltimore had three companies reaching six ports, including Boston and Savannah. The interest of the year centered in the rapid and mysterious consolidation of at least nine companies in the hands of Chas. W. Morse. His plans were uncertain, but he was in a position to go far towards controlling rates where he had no competition, or to make lively war with the two great railroad coasting line owners, the New York, New Haven & Hartford and the Southern Pacific. These companies made some defensive moves. The latter company announced† its intention of ordering very large new ships and of improving the service and extending it to give Galveston and New Orleans connections for New York, Philadelphia and Baltimore with stops also at Havana. The New Haven road purchased the Boston and Philadelphia steamship line and the fleet of the Merchants & Miners' Transportation Co.

The ten companies controlled by Mr. Morse in 1907 were, first, the Kennebec, Boston & Bangor Steamship Company with services from Boston to Maine points; second, the Eastern Steamship Company with lines from Boston to Portland, Eastport and New Brunswick ports; third, the Clyde Line with 21 steamers running from Boston to Charleston, Brunswick (Georgia) and Jacksonville; from New York to Philadelphia, Charleston, Jacksonville, Wilmington, N. C., Georgetown, S. C., and lastly to ports in San Domingo; fourth, the Maine Steamship Company, which with the Eastern Steamship Company has 22 ships, New York to Portland; fifth, the Metropolitan Line, four ships, New York to Boston; sixth, the Mallory Line, 11 ships from New York to Mobile, Brunswick, Ga., and Galveston; seventh and eighth, two lines on the Hudson river; ninth, the New York and Porto Rico Steamship Company with nine ships; and tenth, the Ward Line to Cuba with 20 ships.*

From the examination of such an array as this it becomes plain why the newspapers referred to Mr. Morse's almost complete control of the Atlantic and Gulf shipping. He had more than half of the companies, much more than half of the ships and a complete equipment of services to the whole coast and all of the Greater Antilles except Jamaica. The lines that remained without the grip of Mr. Morse or a strong railroad company were few and comparatively insignificant. The developments of the enterprise were watched with great interest by persons taking cognizance of the coastwise situation. Despite the many theories few anticipated the sudden and spectacular toppling of the whole structure.

The structure itself was impressive, but showed its weakness from afar. Physically its anatomy was good. With one focus at Boston many lines radiated to the eastern ports. New York, the greater of the two service foci, had a fine array of lines to the southward, including as extreme ports San Juan, Porto Rico and Vera Cruz. With these southern lands there is great and growing trade. The service groups were finally articulated by lines connecting New York and Boston.

The elements of weakness were financial. Some of the purchased companies were secured at a high figure. The whole was held by a holding company, "The Consolidated Steamship Lines Company," which had an ambitious scheme of capitalization for replacing $86,757,000 of securities with $148,757,000. Watering stock on land is one thing, but watering it on the water is another—it seems to be a case where like cures like. The real property value of the 97 steamships, 65 lighters, seven tugs and the wharves, piers, etc., was put at $45,000,000 by the bankers who tried to promote it on the basis of prospective profits because "The fundamental idea of this consolidation was the benefits to be derived from concentration of control which would result in the working of all lines under one management, the securing of the lowest possible cost of operation, the elimination of idle tonnage, the curtailment of pier room, harmonious working arrangements between the various lines, the most favorable price for the purchase of supplies and fuel, the lowest cost of insurance, repairs, legal expenses, etc."

High purchase prices, watered stock, over-building of new ships and strong competition with strong rivals were bad, but despite these drawbacks, some well-informed steamship managers think that he might have succeeded had he stuck to the shipping business. But this was not to be. Mr. Morse busied himself in Wall street, where high finance, trust companies, pyramid banking, corners in copper and alliances with Mr. Heinze caused his financial downfall to be one of the first symptoms of the 1907 panic. The steamship pyramid fell with the banking pyramid, and by the end of October, 1907, the great holding company of the year before had become an empty shell. Its 120 millions of securities were worth six millions, its New York offices even were closed up and its headquarters removed to Boston. Within a week the underlying companies were transferred to their old managements. In explanation of this move, H. P. Booth, President of the Cuba Mail Steamship Company, said: "The different lines forming the Consolidated Steamship Co. will in future be run independently, just as they were before the consolidation. We shall attend to our business just as if there had never been a consolidation, and the other companies will do the same as we do." Any earnings after paying interest on the underlying bonds were to go to the Consolidated Company.

But this reorganization was insufficient and by February, 1908, the clamor of the holders of unpaid coal and other bills was so great that receivers were appointed in three states, and the final dissolution of this greatest of coastwise combinations into its original elements was assured. For a time it was questionable even if its promoter would be able to maintain his personal liberty while attempting to extricate himself from his wonderful financial tangle.

(To be continued.)

New York Commercial, July 3, 1907.
†*New York Commercial*, Feb. 15, 1907.

New Railroad in Africa.

The Benguella Railroad is now being built between Lobito and Katanga, Africa. The principal object of the new road is to tap the rich mineral field of Katanga, in the southern part of the Congo Free State. It will traverse the entire province of Angola and open vast areas to commerce. It may eventually be extended to connect with the Cape to Cairo and Rhodesian systems. This would shorten the journey to Pretoria or Johannesburg by 3,000 miles, and reduce the time occupied in transit by four or five days. It is expected that the line will reach Katanga in about four years. It will open up a copper industry which, it is believed, will become one of the greatest industries in Africa. Besides copper, the minerals of Katanga are tin and gold.

Marine Review, Mar. 14, 1907.

GENERAL NEWS SECTION

NOTES.

The pay of freight handlers on certain districts of the Erie has been reduced from $1.50 to $1.35 a day.

It is estimated that 20 per cent. more people went to the New Orleans Mardi Gras festivals this year than last.

It is understood that over 200 short-line railroads have joined in a petition to Congress for a readjustment of the pay for carrying mails.

The Pennsylvaania Railroad has opened a new headquarters at Trenton, N. J., for the instruction of motive power men of the New York division in the operation of air brakes.

The third of the Pennsylvania's four tunnels under the East river, connecting New York and Long Island City, joined its headings on March 5. The fourth may be through by the end of this week.

The Erie is said to have annulled the movement of all freight trains on Sunday, except those carrying live stock and perishable merchandise. The order will remain effective until business conditions improve.

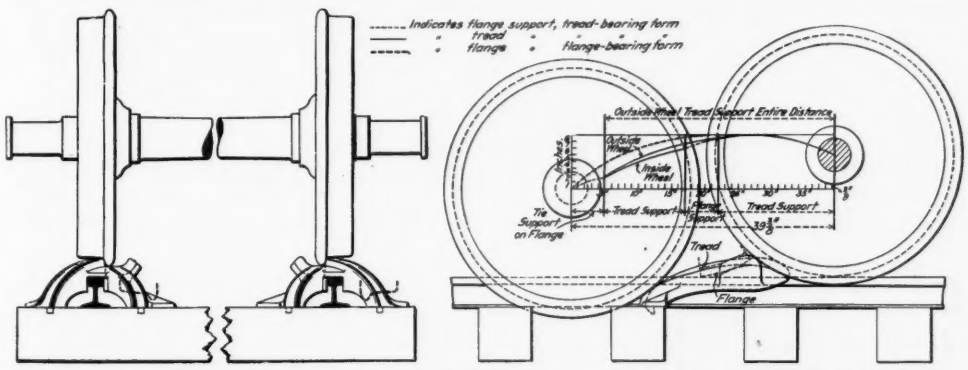
The Baltimore & Ohio has announced that it will restore, on April 1, the old rate of $1.15 per ton on bituminous coal from the Fairmont district to Cleveland and Lorain. The rate has been $1.05 for some little time.

The Burlington announces for the coming summer excursions to Colorado common points between June and October, on the same basis as last year without regard to the efforts to maintain passenger business on a uniform 2-cent basis.

The Boston & Maine has sent a circular to its conductors, trainmen and firemen asking them to accept a 5 per cent. wage reduction to continue only until July 1, it being agreed that upon the first day of July this reduction shall be discontinued. This arrangement has been accepted by the employees of the road.

Announcement is made that the United States Steel Corporation has 95,000 stockholders on its books, a number considerably larger than any before recorded in the history of the company. The Steel Corporation believes that the entire number of shareholders probably approximates 125,000, owing to the fact that many bankers and brokers carry blocks of Steel securities under one name for a large number of holders.

The Wisconsin Railroad Commission has dismissed a complaint against the use of gasolene motor cars between Madison and Freeport, Ill., on the Illinois Central Railroad. The complaint was made on the ground that the motor was "dangerous and inadequate as a means of locomotion." The commission, in dismissing the complaint, held that the use of the motor cars marks an advance in railroading and will result in great benefit to the public.

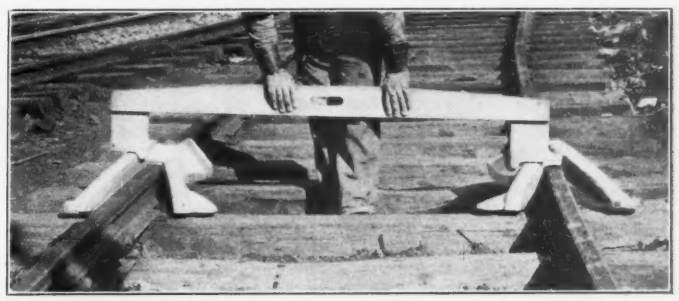


Comparative Wheel Travel on Tread-Bearing and Flange-Bearing Re-Railers.

The Interstate Commerce Commission is opposed to the Fulton bill prohibiting railroads from advancing rates in the face of a protest made by a single shipper until the commission shall have passed upon the reasonableness of the increase. The commission says that to give to the protest of a single shipper the effect of preventing the advance of any rate until the reasonableness of that advance can be affirmatively determined by the commission, would establish a hard-and-fast rule of doubtful fairness to the railroads and of questionable advantage to the public. Until conditions become more stable, the commission believes that wider latitude of discretion on the part of carriers than this measure allows, should be permitted.

The Sargent Re-Railer.

Two improved forms of car replacers, on which the treads of the wheels, instead of their flanges, bear, are illustrated herewith. The principle on which all car replacers work is to raise the wheels by inclines and guide them laterally to the rails by ridges or grooves engaging on the flanges, or by sloped surfaces down which the wheels slide to the rails. By using the tread-bearing principle in the replacer here shown, the concentration of weight on a point on the wheel flange is avoided, thereby reducing the unit stress on the bearing surface, and also the resistance to lateral movement which would result from the flange cutting into this surface.



Straddle-Rail Type of Sargent Re-Railer.

Alongside-Rail Type of Sargent Re-Railer.

To illustrate the advantage of picking up the wheel on its tread instead of the flange, the accompanying chart was prepared. It shows graphically the travel of a 36-in. wheel from a position off of the rail, between two ties, to complete rerailment, and shows the proportionate rate of elevation for both the tread-bearing and flange-bearing forms. It will be observed that the former affords tread support for the outside wheel for the entire distance, and for the inside wheel for all but 15 per cent. of the distance. The initial lift for this form as compared with the other is lessened by an amount equal to the height of the flange, or 1⅛ in. Also, the use of wooden wedges to start the wheel on the replacer is unnecessary; the derailed wheel rests on the ties on its flange, so that the tread runs directly on the replacer.

Another advantage claimed for this form of replacer is that because of the tread-bearing construction the metal may be so disposed as to produce a lighter section than commonly used, without sacrificing strength. The weight of a pair of either of the two types—straddle-the-rail and alongside-the-rail—is from 160 to 180 lbs., as compared with some other replacers weighing 220 to 270 lbs. George H. Sargent, Chicago, is the designer.

Waterproofing a Track Elevation Bridge on the Lake Shore.

The track elevation bridge on the Lake Shore & Michigan Southern at Sixteenth street and Park Manor, Chicago, was waterproofed with "Sarco" waterproofing. As on most track elevation bridges, the space below ties was small and it was essential to have a hard-surfaced, elastic waterproofing which would withstand the effect of vibration from moving loads and the cutting of the rock ballast. A first coat of "Sarco" primer No. F, was thoroughly brushed over the surface of the concrete to form an anchorage for

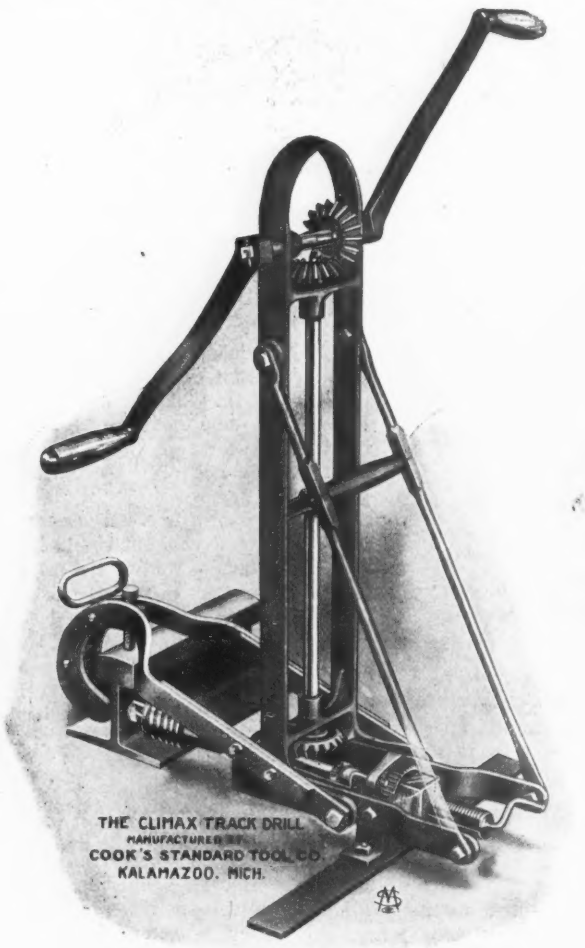
the heavier following coats. Next a coat of "Sarco" No. 6 waterproofing was mopped on while hot. Above this were laid two coats of "Sarco" mastic with joints broken, about a 6 in. lap being allowed. These coats of mastic were made from "Sarco" mastic and flux, and grit about the size of torpedo gravel No. 2, in such proportion as to form a hard surface and yet be elastic enough to take care of contraction and expansion and vibration without checking.

The mastic was taken from the mixing kettle and poured on the concrete, being floated fairly smooth with a wooden spatula. The joints were made by using a strip of wood ⅝ in. thick against which to work the mastic waterproofing. After the mastic was applied, a coat of the No. 6 waterproofing was mopped on the surface while hot. The ends of the bridge were waterproofed by carrying a burlap curtain over the drain. This curtain was made by applying a coating of "Sarco" primer to the surface of the concrete, followed by a coat of No. 6, a layer of burlap, another coat of No. 6, a second layer of burlap and a final coat of waterproofing, forming an impervious curtain to carry the water from the bridge floor to the drain. This method, it is claimed, makes a satisfactory, durable and efficient waterproofing for the special needs of track elevation work. The work was done by the Standard Asphalt & Rubber Co., Chicago.

Climax Track Drill with Forged Steel Hooks.

An improvement in the "Climax" track drill is shown in the accompanying illustration. The new feature is a forged steel hook. The regular hooks, which answer well the requirements of ordinary work, are made of malleable iron and therefore will break, and when broken they must be replaced with new ones. To do away with this trouble the forged steel hook was designed. It is made amply strong, the material being $^{9}/_{16}$ in. x 1½ in., and it is fastened to the body by ⅝ in. bolts, which are ⅛ in. larger than used with the malleable iron hooks, to obviate shearing them off.

The form of the hook makes it possible to drill a hole within



Improved Climax Track Drill.

½ in. of the end of the rail. The set screw at the top saves making adjustments at every hole, one setting only being necessary. The handle is a convenience in moving, and also in collapsing the drill for the passage of trains. Another device, quickly adjusted, enables the hook to be extended over a guard rail or a patent rail joint, which is a great convenience and a time-saver. This hook permits the use of a special combination chuck for either flat or twist-drill bits; this chuck is too long for the ordinary hooks. "Climax" track drills are made by Cook's Standard Tool Co., Kalamazoo, Mich.

If the State Mined the Coal.

The retail price of coal in Philadelphia is always an important theme in that city of small salaries and keen economists. State ownership finds favor with many. What a fine thing that would be! Quay is dead, but his spirit still lives. Think of the rake-off on the $50,000,000 of necessary purchases each year for the hard coal mines! Mules at 25 cents per pound, pipe at 10 cents per cu. in., rope 3 cents an ounce, and other mystifying bills, as for furnishing the Harrisburg capitol! Under state control coal would cost the people of Philadelphia $20 per ton.—*Coal Trade Journal.*

Scherzer Rolling Lift Bridge at Cleveland, Ohio.

The Cuyahoga river winds for several miles through the city of Cleveland. It was originally narrow, shallow and crooked, but many improvements have been made, and it is now navigable for large vessels. The river is spanned by more than 20 bridges, both highway and railroad. Nearly all of these structures were originally

End View, 230-ft. Scherzer Bridge, Showing Method of Construction Without Interference with Traffic.

of the center pier swing type, a number of them have been removed and replaced by rolling lift bridges.

The Baltimore & Ohio crossed the old river bed (a short branch of the Cuyahoga) on the line of West River street to reach the ore docks on the north side of the river. A long span single leaf Scherzer rolling lift bridge was placed in service at this point a few months ago, replacing a swing bridge used by the railroad company for many years. The accompanying plan contrasts the channels of the old and new bridges. The old bridge had its center pier on the westerly side of the river, with an approach extending well out into the channel on the opposite side. In the new structure the main supporting piers on which the bridge rolls are on the easterly side of the river with the front or rest pier on the edge of the far side of the channel, making the entire width of the river available for navigation. The plan illustrates, too, the particular advantage of the rolling lift bridge in making available all dock space adjacent to the bridge, the disadvantage of a swing bridge in this respect being particularly apparent when the main pier is at one side of the channel, as was the case in this instance.

Drawings of this bridge were shown in the *Railroad Gazette* of March 15, 1907. The movable span is 230 ft. long, center to center of bearings. It is the longest span single leaf bascule bridge in the

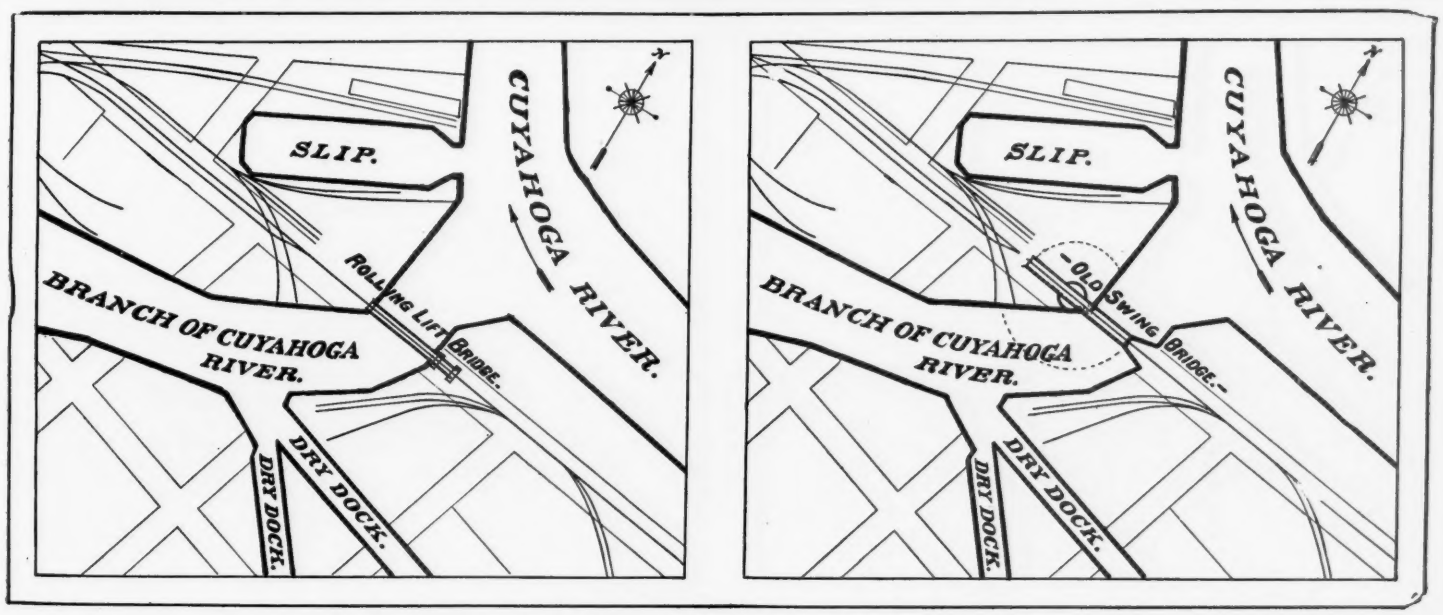
world, the clear channel for navigation, measured between faces of piers, being 210 ft. The total length of steel work, including the short plate girder fixed approach span at the rear end of the bridge, is 334 ft. The bridge is 20 ft. wide, center to center of trusses, and the minimum clearance above the ties is 22 ft. The counterweight is of concrete carried in steel boxes in the plane of each truss, the bridge being counterweighted so as to be at rest in all positions.

Side View of 230-ft. Scherzer Bridge in Cleveland, Under Construction.

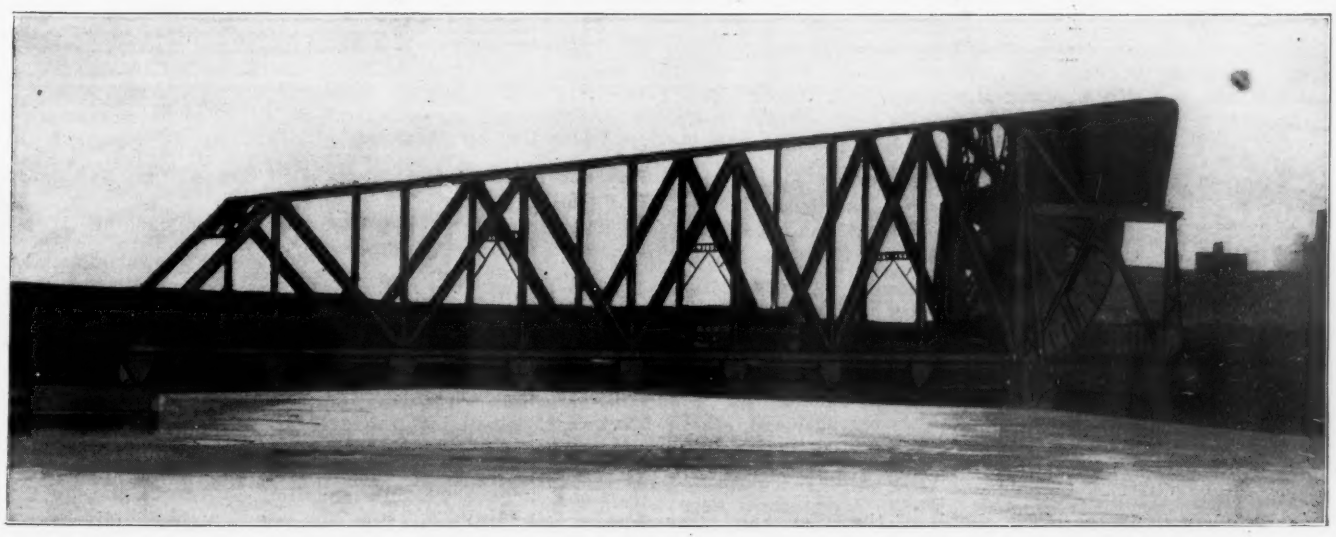
It is operated by two a.c. electric motors of 75 h.p. each, the controller governing the motors being in the operator's house. The motors are equipped with solenoid brakes operated by an independent switch on the switchboard in the operator's house. Power is applied in the operation of the bridge by pinions on the main operating shaft engaging with fixed racks placed on independent supports outside of each truss. The operator's house also contains indicators which show to the operator, both day and night, all positions of the bridge during operation. Indicators are also provided showing the positions of the end latch. Signals are placed at each end of the bridge interlocked with derailing switches and with the end latch and main operating controller.

The substructure consists of one front pier, three main piers, carrying the track girders on which the bridge rolls, and an abutment supporting the rear end of the plate girder approach span. These piers are of concrete carried on piles.

The bridge was erected without interfering with traffic over the old swing bridge or with the operation of the old bridge for the passage of vessels. Two of the photographs show the method of erection, the front pier of the new bridge being built under the old swing span on the channel side of the center pier. The main piers of the new bridge were built under the approach to the swing bridge, the superstructure being erected on these piers



Location of New Lift Bridge and Old Swing Bridge Over Cuyahoga River.

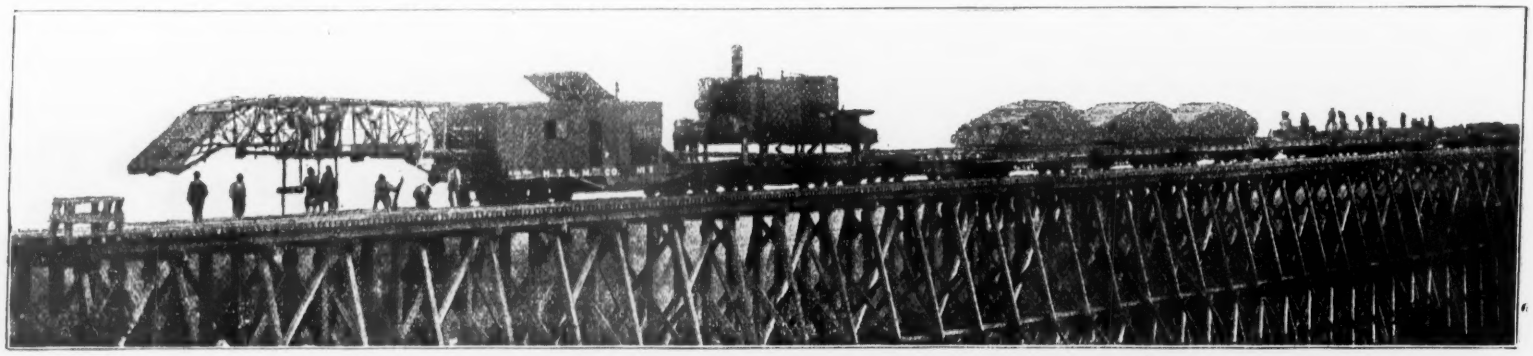


Scherzer Bridge in Closed Position.

so as to provide ample clearance for the operation of trains over the old bridge at all times. The building of the bridge was in charge of J. E. Groiner, Assistant Chief Engineer of the Baltimore & Ohio. The superstructure, operating machinery and electrical equipment was designed by the Scherzer Rolling Lift Bridge Co., Chicago, which also supervised the construction and erection. The substructure was designed and built by the railroad. The superstructure was built by the King Bridge Co., Cleveland, Ohio, and the steel work erected by the Pittsburgh Construction Co.

The Hurley Track-Laying Machine.

The Hurley track-laying machine, illustrated herewith, does its work automatically. A pair of reversible, stationary engines supply power for operating the machine and for propelling the construction train of some 30 cars. The supply car following the

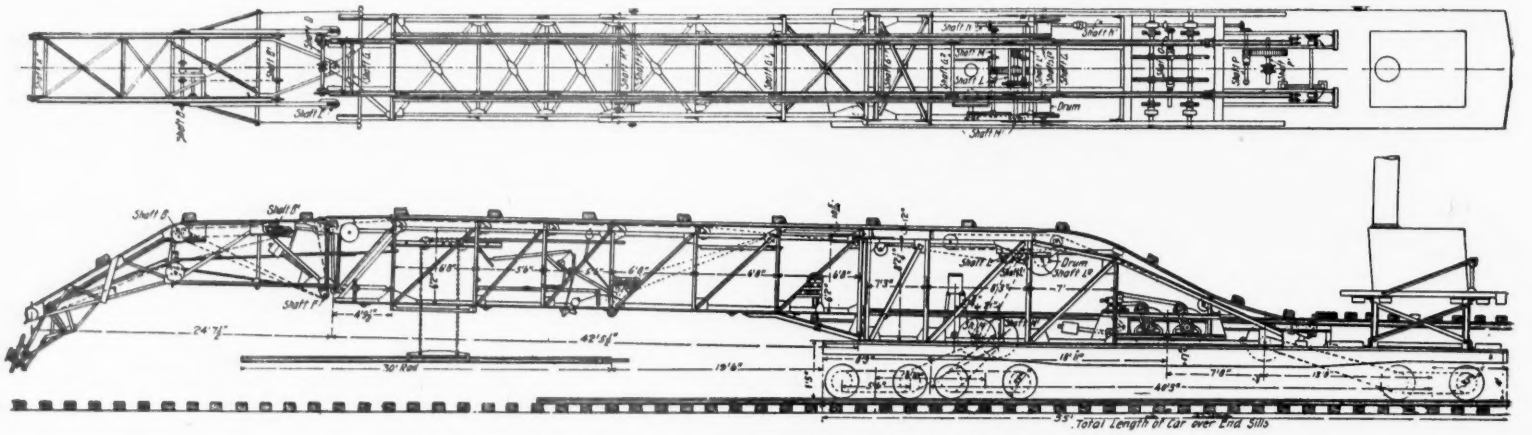


Hurley Track-Laying Machine on the Chicago, Cincinnati & Louisville.

machine has an elevated platform for coal and water, and the rails and ties pass under this platform to the machine. The cars nearest the machine carry the ties and the rail cars are back of these.

The rails and ties are moved forward to the machine car as follows: The construction train consists of ordinary flat cars, each equipped with two flanged rollers, one on each side, 7 ft. center to center, equidistant from each end of the car. The rails are fed to these rollers from the rear cars by a hoist, and are connected together by inserting one bolt in each end of their angle bars. The continuous line of rails thus formed on either side, from the rail cars over the tie cars and to the machine, are utilized as tie conveyors. The tie cars are provided with a crossing plank on which the ties are loaded so as to permit the rails to pass over the rollers and freely under the ties.

On each side of the machine car, 7 ft. center to center, is a cluster of upper and lower power rollers which grasp the rails between them and pull the entire line of connected rails forward.



Plan and Elevation of the Hurley Track-Laying Machine.

Work is begun on the tie car nearest the machine. As the rails pass beneath the ties, men roll the latter down on to the moving rails, as many ties being placed on each rail length as are needed in track. The ties are carried to the machine in this way, the tie men working backward from car to car.

From the front end of the machine car, extending over the roadbed and about 8 ft. above it, is a 68-ft. steel truss. When the rails with the ties arrive at the machine they separate. The required number of ties per rail are delivered, one at a time, by a trip, to an endless chain tie conveyor (with attachments) and are carried over the top chords of the truss to its extreme end, where they are deposited on the roadbed, one at a time, as the machine moves forward, thus spacing them so that they are easily straightened by two men.

The rails move along the lower chords of the truss, and, after passing through the friction rolls previously mentioned, they are disconnected from those in the rear by taking out one bolt and slackening the other, leaving the angle-bars on the rear end of each rail. After the rail is disconnected it is brought forward by means of power rollers located on the lower chords of the truss to a point about 20 ft. in advance of the machine car wheels. Here the rail is grasped by specially constructed tongs and lowered until it drags on the previously laid rail. When within about a foot of the end of the latter it is swung forward by one man until the angle bars drop over the ball of the first rail, when it gravitates to place. The clamp over the angle-bars then is applied and the tongs released. The joints are completed while the train is moving the 20 ft., and the quarter spiking is continuous.

The gearing is so arranged that as the train moves forward it supplies the required amount of material at the front. The front end of the truss is made to admit of swinging to curvature and depositing the ties to the center line. It is immaterial whether the rails are laid with square or broken joints, as each side is worked independent of the other.

Among the claims made for it are: The machine car has high tractive power while the actual power consumed is small.

The machine is moving constantly though slowly in order to economize the power and time usually lost by stops and delays. It requires no locomotive, and therefore saves this cost.

It begins laying track in 15 to 20 minutes after starting to connect up; it can be stopped and disconnected by simply uncoupling cars from machine.

It lays track to line, to any curvature, on any grade, on trestles, or in tunnels. Has been successfully operated in long tunnels by artificial light. Lays track equally well night or day, in winter or summer, and in any kind of weather.

It lays track at the rate of 2 to 4 miles a day. The capacity of the machine is determined by the number of rails that can be laid and connected in front. On one occasion 84 rails per hour were laid on each side. Forty good men will lay and quarter-spike 3 to 4 miles per day.

The office of the Hurley Track-Laying Machine Co. is at 1740 Railway Exchange building, Chicago.

For Railroad Library at Wisconsin University.

James J. Hill has given the University of Wisconsin, Madison, Wis., an additional $2,000 for the development of the "James J. Hill Railway Library," which was established by him with an endowment of $5,000 in 1905. Nearly 9,000 books, pamphlets, periodicals and papers have been secured for the library. The material relates to the history and development of railroad systems of England, Germany, France, Belgium and Holland, besides those of the United States. Mr. Hill's gift was the result of his interest in the work of Prof. Balthazar H. Meyer, of the department of political economy

in the University of Wisconsin, and chairman of the Railway Commission of Wisconsin, while Prof. Meyer was securing material for his monograph dealing with the Northern Securities case, published some time ago.

Report on Quebec Bridge Failure.

The three commissioners appointed by the Canadian government to investigate the cause of the collapse of the Quebec bridge, August 29, 1907; Henry Holgate, C.E., John G. C. Kerry, C.E., and John Galbraith, Dean of the Faculty of Applied Science and Engineering in the University of Toronto, have presented their report to the Canadian Parliament. The commissioners do not think that either the general design of the Quebec bridge, the methods of financing the enterprise, the payments of money that have been made to or by the company, or in its interest, or the obligations that the company has undertaken under various contracts and agreements have direct connection with the fall of the bridge. Their positive findings are as follows:

(a) The collapse of the Quebec bridge resulted from the failure of the lower chords in the anchor arm near the main pier. The failure of these chords was due to their defective design.

(b) The stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

(c) The design of the chords that failed was made by P. L. Szlapka, the Designing Engineer of the Phoenix Bridge Company.

(d) This design was examined and officially approved by Theodore Cooper, Consulting Engineer of the Quebec Bridge & Railway Company.

(e) The failure cannbt be attributed directly to any cause other than errors in judgment on the part of these two engineers.

(f) These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty, or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day and proved to be insufficient for the task.

(g) We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practice. The specifications were accepted without protest by all interested.

(h) A grave error was made in assuming the dead load for the calculations at too low a value and not afterward revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength, because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Sziapka and accepted by Mr. Cooper and tended to hasten the disaster.

(i) We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable, owing to the manifest risk of human life involved.

(j) The loss of life on August 29, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge & Railway Company and for the Phoenix Bridge Company.

(k) The failure on the part of the Quebec Bridge & Railway Company to appoint an experienced bridge engineer to the position of Chief Engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge & Railway Company.

(l) The work done by the Phoenix Bridge Company in making the detail drawings and in planning and carrying out the erection and by the Phoenix Iron Company in fabricating the material was good, and the steel used was of good quality. The serious defects were fundamental errors in design.

(m) No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the judgment of the designers were not made.

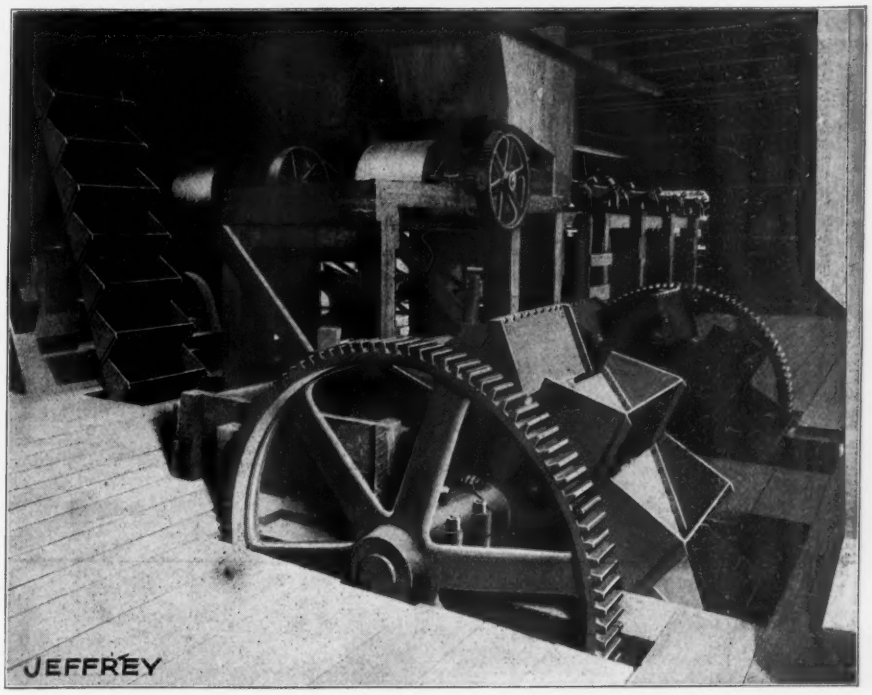
(n) The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

(o) The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted, and the complete confidence that was placed in his judgment by the officials of the Dominion Government, the Quebec Bridge & Railway Company, and the Phoenix Bridge Company was deserved.

The report contains appendixes describing the history of the proposal to bridge the St. Lawrence river at or near the city of Quebec; the history of the Phoenix Bridge Company; the effect of financial limitations upon the design of the bridge; the history of the development of the specifications; a description of the organization of the development of plans and of the method followed in the design; a statement of material, shop work and inspection; a statement discussing transportation and erection, and a discussion of the difficulties that arose during erection, and of the events at the time of the collapse of the structure. Some of the parts of especial interest will be treated more fully in a subsequent issue of the *Railroad Gazette*.

Elevating and Conveying System of the Cedarcliff Stone Co.

An unusually large stone crushing and shipping plant was recently completed by the Cedarcliff Stone Co. at its works near Cedarcliff, N. Y. An important feature of the plant is the complete system of elevators and conveyors for handling stone through the various processes of preparation and shipment. A series of elevators and conveyors takes the stone from the crushers to the revolving screens and thence to the storage grounds. Another series delivers the sized product from the storage grounds to cars, or to vessels on a nearby river, as the case may be. The first system, illustrated herewith, consists of three elevators and two belt conveyors. Each of the elevators is 65 ft. high from center to center of wheels. Two of these elevators, standing side by side, handle the product of one No. 9 and four No. 6 Gates crushers. The stone from each elevator is delivered to a revolving screen, from which the tailings go back to two No. 6 crushers on each side and are recrushed. Everything which passes through the screens is received by the third elevator, which stands directly behind the other two, and which delivers it to the finishing screen in the top of the building.



Elevators to Crushers and Screens, and Belt Conveyors to Storage Bins.

The finishing screen separates the stone into 2 in. and ¾ in. sizes and screenings, which pass through a ⅜-in. hole. The screenings are carried away about 100 ft. by a 14-in ."Century" belt conveyor. The 2-in. and ¾-in. products are carried to the storage grounds by separate belt conveyors 24 in. and 18 in. wide, respectively. They are shown in one of the accompanying illustrations. They discharge into the proper compartments by automatic trippers.

The plan of ground storage is, so far as we know, unique in stone-crushing plants. It is said to be much cheaper in first cost and maintenance than bins. The plan is the same as is used for coal, the storage space being 160 ft. x 100 ft. The distributing conveyors are 35 ft. above the ground, giving a storage capacity of about 8,000 cu. yds.

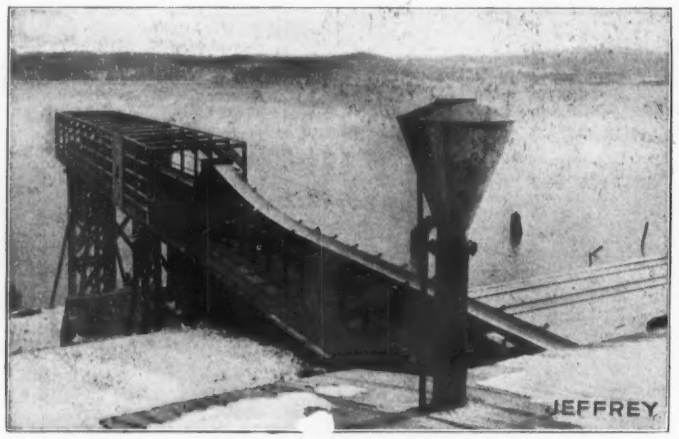
The distributing conveyors rest on concrete columns 35 ft. apart, center to center, each column being 12 ft. x 7 ft. in plan, and having a ventilating shaft 8 ft. x 3 ft. in its center from top to bottom. Underneath the column, in the center and running the length of the storage ground, is a conduit cut out of solid rock, 8 ft. x 8 ft.

inside and 160 ft. long. The walls and floors are concrete and the roof is of 12-in. I-beams, 2 ft. apart, filled in with concrete. In this roof bin-gates are placed every 6 or 8 ft. Over the tunnel stone will be piled to a height of 35 ft.

To convey the crushed stone to railroad cars or to barges a 36-

Conveyors over Storage Bins.

in. belt conveyor travels the length of the tunnel. It receives the stone through the roof gates and delivers it to an elevator 45 ft. high, center to center of wheels. This discharges to another belt conveyor, 36 in wide by 200 ft. long, which goes over the railroad tracks and to the wharf, as illustrated herewith. The stone is discharged by a tripper either at the wharf or into a small pocket over



Conveyor from Bins to Cars and Vessels.

the railroad tracks, from which it is loaded into cars. The loading conveyors have a capacity of about 400 tons an hour. They are driven independently, so that the barges or cars can be loaded without reference to the main plant.

The elevator buckets, which are 30 in. long, are carried by two parallel chains of special design, made for the heaviest work. They are the "Michigan" type of Jeffrey "Climax" steel chain, made double width to give greater bearing surface on the head and foot wheels. They are designed to carry a steady load of 6 to 7 tons, and have a factor of safety of 15.

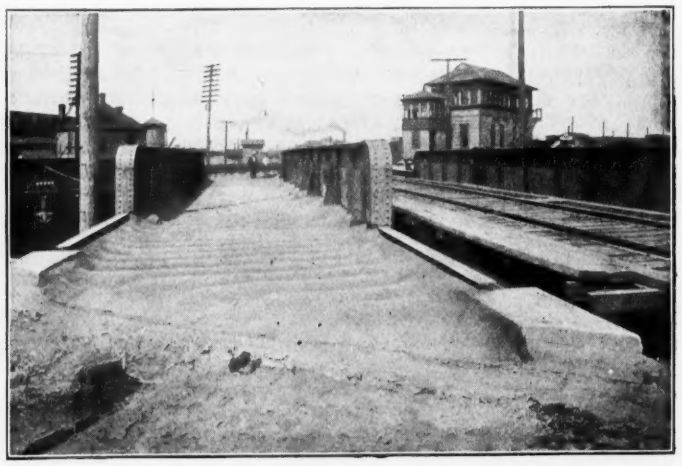
This elevating and conveying system was installed by the Jeffrey Manufacturing Co., Columbus, Ohio.

Bitumen-Emulsion Waterproofing Compound.

Wunner's "Bitumen-Emulsion" waterproofing is a German preparation for use on masonry or concrete. Among the properties claimed for it, verified by tests and in service, are: It is non-porous and impermeable to water under all pressures; makes an absolute bond with the protected material, and if this is metal expands and contracts with it without injury to the bond; is unaffected by heat, cold or sudden temperature changes; does not separate from masonry under settlement, jars or vibration, and does not break unless the foundation breaks first; is not abraded by wind or weather, will not decompose or disintegrate, and is insoluble; does not interfere with the setting of cement mortar, and is easily applied.

This waterproofing compound is a thick black fluid which mixes readily with cement mortar. It is applied by mixing a small quantity in ready-made cement mortar or in concrete. A report of a test made in Germany by the Royal Building Inspection Department at Saarburg at the request of the Imperial authorities shows excellent results for this compound. The test was in competition with seven other highly recommended waterproofing materials. As a result of the tests the German Empire became the largest consumer of the Bitumen-Emulsion, using it in fortifications, harbors, railroads, bridges, canals, canal locks, etc.

This material has been in use in this country for about a year. A photograph is shown herewith of the Junction Avenue bridge of the Wabash in Detroit, Mich., which is waterproofed with this material. This bridge is of I-beam and concrete construction. It is claimed that the bond between the metal and the waterproofing coat is absolute, and is unaffected by the vibration, which is con-



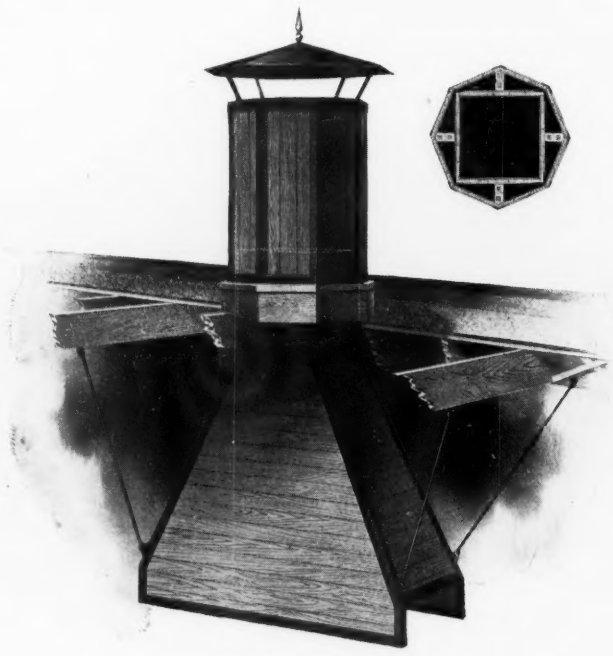
Junction Avenue Bridge of the Wabash, Detroit, Mich.

siderable. The Wabash bridge, at Forest Park, St. Louis, which is of ornamental design (*Railroad Gazette*, Oct. 28, 1904), was waterproofed with the Bitumen-Emulsion last May, after other materials had failed. In the basement of the West Street building, New York City, leakage was completely stopped by this compound after various other methods had been tried without success.

Theodore F. Koch & Co., Chicago, are sole agents for the United States.

A New Wooden Smoke-Jack.

The smoke-jack here illustrated represents several years of experiment and effort to produce a light, durable, fireproof jack that will stand the test of acid, smoke fumes, steam, etc., without decay or corrosion. It is made of the best quality of dressed and matched lumber. The inside surface is smooth and offers no projections or cracks in which sparks can lodge. The wood is noncombustible. It is said that tests extending over three years have



The Dickinson Smoke-Jack.

proved this, and that the fireproofing compound is hermetically sealed within the cells of the wood so that its effectiveness is permanent. Cast iron bands, which are specially treated to resist the effect of smoke and acids, are placed outside and inside the jack to give it the necessary strength and rigidity.

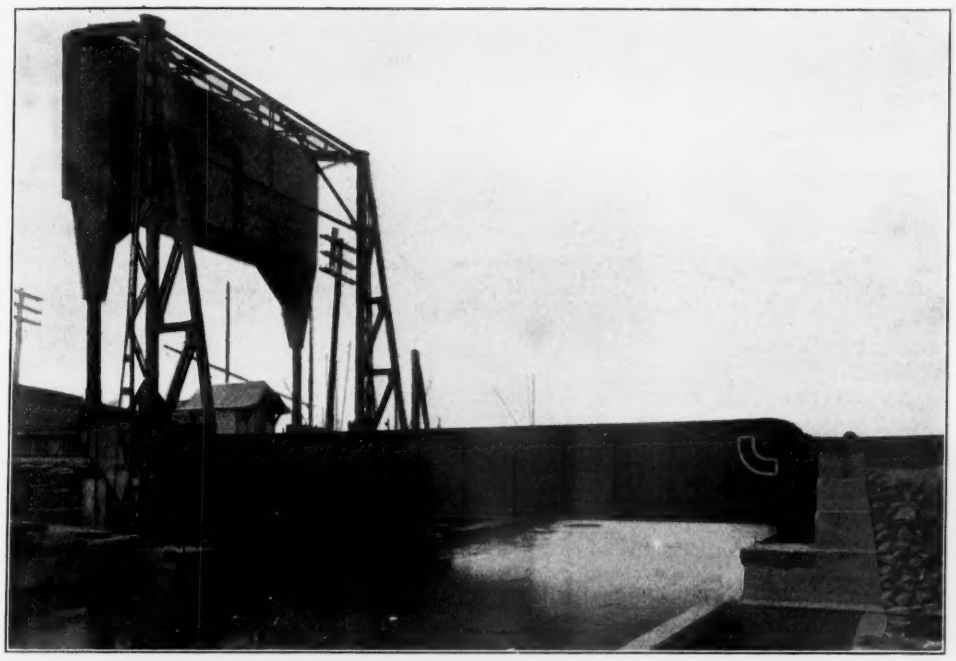
The part of the jack above the roof is octagonal in section so

as to better resist wind pressures. The short inside diameter is 36 in.; below the roof the jack is 24 in. square. This allows ample ventilating space for removal of the steam, smoke and gases from the upper part of the roundhouse. The ends of the hood are given a steep pitch to prevent smoke from rebounding into the house. The hood is 8 ft. long, 6 ft. high and 40 in. wide at the bottom, with 12 in. hanging sides to enclose the locomotive stack. These dimensions, however, can be made to suit any requirements.

These jacks are made by Paul Dickinson, Inc., Chicago.

Strauss Trunnion Bascule Bridges.

The trunnion bascule type of drawbridge is almost as old as the swing bridge, there being many early examples of it in Europe. In 1839 the North Eastern of England built a double-leaf trunnion bascule, which remained in service until recently. In 1867 the city of Copenhagen, Denmark, built a double-leaf highway bridge, 56 ft. 8 in. clear span, which is also still in service. In 1892 the city of London built the famous Tower bascule, which is 226 ft. 6 in. span, c. to c. of trunnions. This is the largest and heaviest bascule in the world.



Strauss Bascule Bridge, Overhead Counterweight Type; Staten Island Rapid Transit.

Strauss Bascule Bridge, Underneath Counterweight Type; St. Louis, Iron Mountain & Southern.

In 1902 the city of Chicago began building a series of trunnion bascules over branches of the Chicago river; it has built seven to date, some of them being unusually large and heavy structures. The city of Milwaukee has five trunnion bascule bridges in successful operation.

The Strauss designs of bascule bridge are claimed to represent the complete development of the trunnion type. The first one was built at Cleveland, Ohio, for the Wheeling & Lake Erie in the fall of 1905. Since then 11 additional bridges of this type have been built, are under construction, or are ordered. These include the monumental Knippels bridge at Copenhagen, Denmark, and the 170-ft., single leaf, double-track bascule bridge for the Chicago & North-Western at Kinzie street, Chicago.

The Strauss designs embrace a number of modified forms of trunnion bridge, all intended to increase economy and effectiveness. The principal features are the pivoted counterweight and the parallel link mechanism, which apply to both the overhead and underneath counterweight types illustrated herewith. The following are some of the claims made: It was the first bascule bridge in which a concrete counterweight was substituted for cast iron. It is the only bascule which is exactly balanced, and, being at the same time positively connected to the foundations, it is free from any danger otherwise attendant on the erection and service operation of such a structure, especially in case of accident. The truss members all center in the trunnions, and all the loads are transmitted directly to the foundations at the same point, in all positions of the span. The trunnions give a surface bearing, thus avoiding any injurious effects of line bearing. The absence of tail locks and other adjusting devices lessens maintenance cost and danger. The ease with which the number of tracks can be increased, the lessened delay to traffic because of the single channel and the greater speed of operation, and finally, its moderate cost, make it a desirable bridge for railroads.

The Strauss Bascule & Concrete Bridge Co., Chicago, is the designer and builder.

A Cast Steel Tie.

The accompanying illustrations show designs for the use of cast steel for a tie body, both in ballasted roadbed and in special structures, such as tunnels. The steel is placed in the ballast or embedded in concrete as part of the permanent structure, and it need not be disturbed in ordinary track work, except as the ballast itself is raised or moved. The metal is so distributed as to give the greatest strength where it is needed and to give a large area of bearing surface underneath the rails. The ribs, flanges, projections and openings are so placed as to provide a firm hold. In the design, three stresses have been considered: the downward pressure under load, the lateral thrust and the tendency of the rail wave under moving trains to lift the tie. The necessary resiliency of the rail support is provided by the wooden block to which the rail may be fastened in any of the usual ways. This block is carried in a pocket formed near the end of the tie; for such maintenance work as ordinary alinement it is evident that the steel portion need not be disturbed.

In designing the cast steel tie it was held that the following requirements should be fulfilled: (1) The tie should be such as could easily be substituted for an ordinary wooden tie in existing track. (2) There should be a certain amount of elasticity in the rail support. (3) After the tie is imbedded in the ballast it should be possible to make the ordinary adjustments necessary to maintenance without disturbing the tie or the ballast. (4) The design should be such that the bearing surface could be varied to suit different kinds of traffic, roadbed and ballast. (5) The tie should resist downward, lateral and lifting forces. (6) The bearing surface should be greater under the rails than under the middle of the tie, to tend to prevent center binding. (7) The tie should not interfere with ordinary provisions for drainage. (8) It should have a definite scrap value if removed within the period of its assumed life. (9) It should be heavy enough, aside from its grip on the ballast, to partially counteract the lifting force of the rail wave.

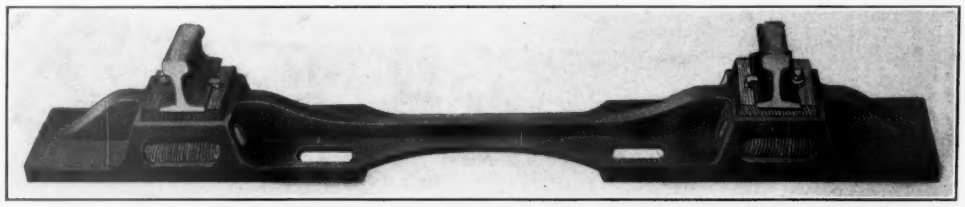
These ties were originally designed for use in tubular tunnels where the bearing surface of the tie outside of the rail is restricted. One of the designs illustrated is for use in concrete roadbed, as in tunnels, paved streets, terminals, etc. The tie designed for ordinary use may be extended to hold a third-rail bracket. It is claimed

that fewer of these need be used to a rail length, and that lighter rails can also be used without lessening the stability of the track.

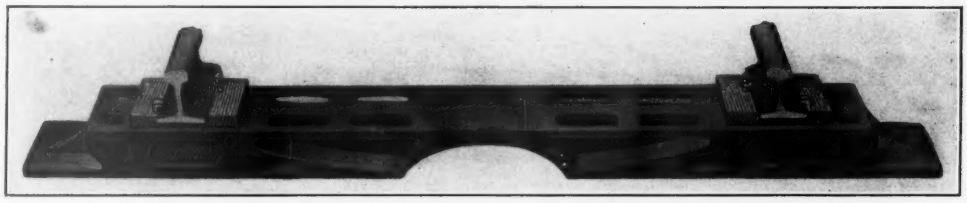
A modification of this tie has been considered. It involves substitution of longitudinal stringers on the permanent steel cross ties instead of the wooden blocks. Paul D. Ford, who was a member of the committee on the form of track construction for the Interborough Rapid Transit subway in New York City, recently calculated that the pressure on the stringers under Cooper's E 50 specifications, or 50,000 lbs. axle load, with axles spaced 60 in. apart and with 100 per cent. allowance for impact, would be 833 lbs. to the lineal inch and 152 lbs. to the square inch, under a rail 5½ in. wide. The calculations of the U. S. Forestry Bureau indicate that 215 lbs. to the square inch is a safe working stress for yellow pine. As a basis for Mr. Ford's calculations, he took creosoted yellow pine timbers 7½ in. wide, 11¾ in. deep and 33 ft. long, the joints between stringers and between rails being alternate. In this design it is proposed to space the ties 55 in. apart, except when laid in concrete or in track not in service during construction, and 33 in. apart at rail joints.

In one design illustrated herewith, the inverted T form of the tie body as shown is reduced in height from 6 in. to 3¼ in., and in width from 7¾ in. to 5½ in., including both flanges. These dimensions are tentative and may be varied to any extent. The pockets for the wooden blocks are closed at each end and on one side, and the end walls incline inward at the top so that the block dovetails into them and is held from lifting. The rails can be fastened to the block or the block replaced without disturbing the ballast or the metal part of the tie. It is believed that the tie should have a long life because of the enduring qualities of cast steel.

The Metal Ties Company, with office at 21 Park Row, New York City, has been formed to handle this tie. J. Stewart Andrews is President, and associated with him are Edgar M. Smith, Charles F. Quincy and James W. Leahy, the inventor of the tie.



Combination Cast Steel and Wood Tie for Ordinary Track.

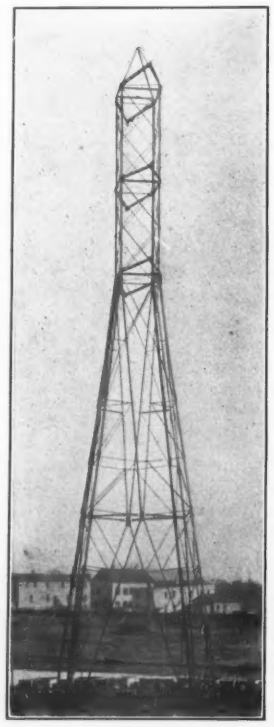


Combination Cast Steel and Wood Tie for Special Track Construction.

Galvanized Steel Poles for Transmission Lines.

The Great Western Power Company, of California, has adopted the Milliken pole, shown herewith, for use in carrying its high voltage power transmission line. It is intended eventually to carry these lines a distance of about 1,000 miles. The power is transmitted on two circuits of three wires each, carrying a current of 100,000 volts. In view of this high voltage and the consequent danger to life and risk from fire involved, great care was exercised in selecting the particular class of poles to be adopted. The pole is designed with three crossarms, the intention being to carry a feed wire on the outer end of each crossarm by suspended insulation. The top of the pole is arranged to take a guard wire. The poles are intended to be used about 750 ft. apart. The bottom of the pole at the ground level occupies a base 17 ft. square. The stub ends of the pole are separate pieces of steel and are of such length as to allow 6 ft. for bedding in the ground. These poles are made entirely of structural steel shapes and are designed to follow the theoretical stresses and produce a pole of given strength and stiffness with a minimum amount of material. There are a great many duplicate pieces, thus making it a simple matter for the purchaser to put the same together in the field.

The poles are designed to stand the following tests: When tested in a vertical position, on an immovable foundation, and with a proper margin of safety a simultaneous horizontal side pull of 1,000 lbs. at the top and 2,500 lbs. at each of the three crossarms, or in other words, a total strain of 8,500 lbs. The crossarms were to support a suspended weight of 1,000 lbs. at their extreme end, and any one of the crossarms to carry at one of these ends a horizontal pull along the line of 3,000 lbs.



Side View of Milliken Pole.

The receivers of Milliken Bros. (Inc.), 11 Broadway, New York City, are manufacturing these poles at Milliken, Staten Island, N. Y., where complete arrangements have been made in the bridge and structural shops for getting out this particular class of structural work.

MANUFACTURING AND BUSINESS.

The Sandusky, Ohio, plant of the Sandusky Portland Cement Co., which was closed down early in December, has resumed work with a full force. The plants at Syracuse, Ind., and Dixon, Ill., are to be started up at once, it is said.

The Lock Joint Pipe Co., 346 Broadway, New York, has secured contracts from the United States Quarantine Department for protecting from marine wood borers, with lock joint pipe, the Department's docks at Charleston, S. C., and Boca Grande, Fla.

The sales of railroad and structural iron paints made by The Alcatraz Company, Richmond, Va., were twice as large during January and February, 1908, as during the corresponding months of 1907. Trade increased particularly in the Middle West and the West.

G. Fred Collins, who has for many years been identified with the railroad supply business as representative of Valentine & Co. and others, and recently as manufacturers' agent in Mexico, has returned to this country to take a position with the Gold Car Heating & Lighting Co., New York.

The Continental Fibre Co., Newark, Del., which started in business in November, 1906, has recently completed an addition to its plant that will enable it to double its output. This company is now one of the largest manufacturers of vulcanized fiber for track insulation. J. P. Wright is General Manager, with headquarters at Newark, and the Wallace Supply Co., Chicago, is western representative.

W. C. Lawson and J. E. Simons have formed a partnership under the name of Lawson & Simons, 505 Fisher building, Chicago, to act as selling agents for various companies. At present they are prepared to quote prices on long leaf yellow pine, oak, fir, creosoted lumber, ties, piling and telegraph poles, tool steel, bolts and nuts, and bar iron and steel. Mr. Lawson has had experience with the American Car & Foundry Co., New York, and has been salesman for the Pressed Steel Car Co., Pittsburgh, Pa., and the Scullin-Gallagher Iron & Steel Co., St. Louis, Mo. Mr. Simons was recently with the Fitz-Hugh Luther Co., Chicago.

To avoid possible confusion through similarity with the name of another corporation, the title Maryland Railway & Electric Supply Co. has been substituted for Maryland Railway Supply Co. of Baltimore city, of which the organization was recently noted in these columns. Changes in the officers of the company have also been made. Charles Elliott is now President and General Manager; Nelson Perin, Vice-President, and Thomas D. Claiborne, Secretary and Treasurer. Mr. Elliott is the son of W. G. Elliott, who was President of the Atlantic Coast Line up to the time of his death. Mr. Elliott served for a number of years in the engineering corps of that road, later going into the railroad supply business, in which he has had considerable experience. Mr. Perin is the son of the late President of the United Railways of Baltimore, and has for some time been engaged in the contracting business, being also Treasurer of the Johnston-Perin Contracting Co. Mr. Claiborne is an engineer and also President of the Johnston-Perin Contracting Co. The headquarters of the Maryland Railway & Electric Supply Co. will be continued at 510 Continental building, Baltimore, Md.

The Fibrous Paint Co., Real Estate Trust building, Philadelphia,

Pa., having succeeded to the business of the Pennsylvania Standard Rubber Paint Co., is now the sole maker of "Standard Fibrous" paint. This is a preservative coating for protecting iron and steel structures. It has for the past ten years been used successfully for the preservation of metal structures under conditions where paint mixed with a linseed oil binder is rapidly disintegrated. By adhering closely to iron and steel, its design is to prevent oxidation by forming an elastic waterproof coating impervious to rust-producing agencies, acid fumes and the mechanical abrading action of exhaust blasts; these properties are especially desirable in the coating of bridges, train sheds, car roofs and other metal surfaces exposed to similar conditions. The Standard Fibrous paint is put up in a variety of colors in one, five and ten-gallon packages ready for use. Sales through agencies have been discontinued and the manufacturers now deal direct with the consumer through their own salesmen.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Augusta Southern.—J. M. Featherston has been appointed Assistant Auditor, with office at Augusta, Ga., succeeding B. Anderson.

Birmingham Southern.—Geo. G. Crawford has been elected President, succeeding J. A. Topping; L. T. Beecher, Treasurer, succeeding W. A. Green; F. B. Winslow, Auditor, succeeding S. A. Cameron, who has been appointed Car Accountant. All have headquarters at Birmingham, Ala.

Brookhaven & Pearl River.—M. E. Olmsted, Secretary, has been appointed General Counsel, with office at Harrisburg, Pa., and his duties as Secretary have been transferred to H. C. Homeyer, General Freight and Passenger Agent, who also becomes Treasurer, succeeding G. C. Lignon. Mr. Lignon continues his duties as Auditor. W. H. Baumes is Comptroller, with office at Buffalo, N. Y.

Canadian Pacific.—W. T. Payne, Superintendent at Vancouver, B. C., has been appointed to the new office of Manager of the Pacific steamship service, having charge of company's interests in China, Japan and Hong Kong, with office at Yokohama, Japan.

Cincinnati, Hamilton & Dayton.—F. M. Carter has been appointed Treasurer, with office at Cincinnati, Ohio, succeeding J. E. Howard, resigned. The office of Assistant Treasurer for the Receiver, previously held by Mr. Carter, has been abolished.

De Queen & Eastern.—C. C. Ray has been appointed Assistant Treasurer and General Freight and Passenger Agent, with office at De Queen, Ark., succeeding T. E. Brown, resigned.

Gulf Line Railway.—J. H. Hillhouse, Traffic Manager at Sylvester, Ga., has been elected also Vice-President. C. H. Reynolds, Treasurer at Sylvester, Ga., is now Secretary and Treasurer.

Idaho & Washington Northern.—J. T. McDevitt, Secretary, has been appointed also Auditor, succeeding W. T. Hireen.

Licking River.—A. Siegworth has been appointed Auditor, with office at Chicago, Ill., succeeding C. M. Mohr, who continues his duties as Treasurer.

McCloud River.—D. M. Swobe has been elected Vice-President and Traffic Manager, with office at San Francisco, Cal., succeeding H. O. Johnson, resigned.

Mexican Central.—W. G. Lerch has been appointed Assistant to the President, with headquarters in the city of Mexico.

Peoria & Pekin Union.—H. K. Pinkney, Secretary, has been elected President, with office at Peoria, Ill., succeeding Curtiss Millard, resigned. The duties of Auditor and all matters pertaining to the traffic department have been assumed for the present by the President. J. F. Kiefer succeeds Mr. Pinkney.

Sandy River & Rangeley Lakes.—The officers of this new company, a consolidation of three narrow (2-ft.) gage railroads in Maine, are: Weston Lewis, President; Josiah S. Maxcy, Vice-President and General Manager; Geo. A. Farrington, Secretary and Treasurer; F. N. Beal, Freight and General Passenger Agent, and F. A. Lawton, Superintendent.

Santa Fe Central.—E. R. Paul has been elected Assistant Treasurer, with office at Santa Fe, N. Mex., succeeding Frank Dibert.

Southern Railway & Navigation.—The officers of this company, which operates a terminal line at Chicago, Ill., also steamers and barges on the Ohio and Tennessee rivers, are: D. K. Jeffris, President; Marvin Hugitt, Jr., Vice-President; A. B. Donaldson, Secretary and General Manager; J. T. Jeffris, Treasurer, and W. T. Beckman, General Superintendent; all with office at Chicago, Ill.

Tionesta Valley.—P. M. Newman, General Manager of this company and President and General Manager of the Susquehanna & New York, has been also elected President of the Tionesta Valley, with office at Williamsport, Pa. W. R. Campbell is Assistant to the President, with office at New York.

Operating Officers.

Arkansas & Louisiana.—M. M. Richey has been appointed Superintendent, with office at Little Rock, Ark., succeeding J. Cannon.

Astoria & Columbia River.—E. E. Lillie has been appointed Superintendent of Car Service, with office at Portland, Ore.

Atlanta, Birmingham & Atlantic.—Alexander Bonnyman, Chief Engineer, has been appointed General Manager, with office at Atlanta, Ga.

Buffalo & Susquehanna.—This road for purposes of economy is now operated in one division instead of in two, as formerly. F. W. Allen, heretofore Superintendent of the Northern division, is now in charge of the whole road, with office at Galeton, Pa. The business heretofore handled by the maintenance of way department is now in direct charge of the Superintendent, who will appoint the necessary subordinates.

Boston & Maine.—Fred A. Hortter, who was recently appointed Superintendent of Car Service of the Boston & Maine, was born on May 8, 1870, at New Brighton, Pa. He was educated in the public schools at Boston, Mass., and in 1889 entered railroad service with the Railway Clearing House Association. The next year he went to the Boston & Maine as a tracing clerk in the car service department, being made chief clerk of the car service department three months later. From 1890 to 1908 he served in this position, and on March 2, 1908, was appointed Superintendent of Car Service, succeeding Hoyt E. Howard, who retired at the age of 70 years after 49½ years of continuous service with the Boston & Maine.

Central of New Jersey.—The office of H. G. Sherman, Superintendent of Telegraph, has been moved from Jersey City, N. J., to New York.

Chicago, Burlington & Quincy.—Robert Rice, Superintendent at Hannibal, Mo., has been transferred to the St. Joseph division, with office at St. Joseph, Mo., succeeding A. N. Willsie, who takes Mr. Rice's place at Hannibal.

Coal & Coke.—Edwin Bower, Assistant General Manager, at Gassaway, W. Va., has been appointed Acting General Manager, with office at Elkins, W. Va., succeeding General Manager W. H. Bower, resigned. J. A. Emmart, Purchasing Agent at Elkins, W. Va., has been appointed Assistant Acting General Manager, with office at Gassaway, W. Va., succeeding Mr. Bower. Mr. Emmart also continues his duties as Purchasing Agent.

Delaware & Eastern.—O. F. Wagenhorst, Chief Engineer, has been appointed Superintendent, with office at Margaretville, N. Y., in charge of the transportation and motive power departments.

Delaware, Lackawanna & Western.—E. M. Rine, Superintendent of the Scranton division, has been appointed Superintendent of the Morris and Essex division, with office at Hoboken, N. J., succeeding C. H. Ketcham, resigned; H. H. Shepard, Superintendent of the Syracuse and Utica division, succeeds Mr. Rine, with office at Scranton, Pa. G. A. Poore, Superintendent of the Bangor & Portland Railway division, succeeds Mr. Shepard, with office at Syracuse, N. Y. William Fletcher, Trainmaster of the Bangor & Portland Railway division, will perform the duties of Superintendent of that division until further notice.

Mexican Central.—G. W. Vanderslice has been appointed Superintendent of Terminals at Ciudad Juarez, Chihuahua, Mexico.

Mississippi River, Hamburg & Western.—A. J. Abell has been appointed Superintendent, with office at Monroe, La., succeeding C. H. Bevington.

Missouri Pacific.—The Central district has been abolished. The superintendents of the Central division and the White River division will hereafter report to the General Superintendent at Little Rock, Ark. The Superintendents of the Joplin, the Wichita and the Southern Kansas divisions will report to the General Superintendent at Kansas City. W. J. McKee, General Superintendent of the Central district, has been appointed General Superintendent, with headquarters at Little Rock, Ark. A. De Bernardi, General Superintendent at Little Rock, has been appointed Superintendent of the Omaha division, with headquarters at Atchison, Kan., succeeding W. E. Brooks, transferred, and of the Northern Kansas division, succeeding W. E. Merrifield, assigned to other duties. Mr. Brooks has been appointed Superintendent of the Joplin division, with headquarters at Nevada, Mo., succeeding G. H. Stapp, resigned. J. F. Murphy, Superintendent of the Memphis division, has been appointed Superintendent of the Central division, with headquarters at Van Buren, Ark., succeeding J. M. Walsh, assigned to other

duties. H. J. Scheuing, Trainmaster at De Soto, Mo., has been appointed Superintendent of the Memphis division, with headquarters at Wynne, Ark., succeeding J. F. Murphy, transferred.

Morgantown & Kingwood.—C. R. Metzler has been appointed Trainmaster, with office at Morgantown, W. Va., succeeding G. W. Glenn.

Portland & Seattle.—See Spokane, Portland & Seattle.

St. Louis, El Reno & Western.—W. M. Bushnell has been appointed General Manager, with office at Fort Smith, Ark.

Southern.—The office of A. H. Westfall, Superintendent of the Northern division, is now at Greensboro, N. C., instead of at Danville, Va. G. P. Walton has been appointed Superintendent of the Danville division, with office at Greensboro, N. C., succeeding W. R. Hudson, transferred.

Spokane, Portland & Seattle.—E. E. Lillie has been appointed Superintendent of Car Service of this road, formerly the Portland & Seattle, with office at Portland, Ore.

Tonopah & Tidewater.—John Ryan, General Superintendent, has been appointed General Manager, with office at Ludlow (Stagg post office), Cal. The position of General Superintendent has been abolished.

Traffic Officers.

Chicago Great Western.—W. H. Burke, New England agent at Boston, Mass., has been appointed General Eastern Agent at New York, succeeding B. G. Saunders. W. A. Dolan succeeds Mr. Burke.

Licking River.—Malcolm Stone has been appointed General Freight and Passenger Agent, with office at Chicago, Ill.

Missouri Pacific.—R. T. G. Matthews, General Agent of the passenger department at Cincinnati, Ohio, has been appointed Assistant General Passenger Agent at Kansas City, Mo., succeeding C. E. Styles, resigned.

Raleigh & Charleston.—A. T. Vannerson has been appointed to the new office of General Freight and Passenger Agent, with office at Marion, S. C.

Raleigh & Southport.—J. O. Hendley has been appointed to the new office of General Freight Agent, with office at Raleigh, N. C.

St. Joseph & Grand Island.—W. H. Bryning, Assistant General Freight Agent at St. Joseph, Mo., has been appointed Assistant General Freight Agent at Kansas City, Mo., succeeding H. V. Clark.

Engineering and Rolling Stock Officers.

Chicago, Rock Island & Pacific.—W. A. Nettleton, General Superintendent of Motive Power of the St. Louis & San Francisco, has been appointed General Superintendent of Motive Power of the C., R. I. & P. See Delaware, Lackawanna & Western.

Delaware, Lackawanna & Western.—T. S. Lloyd, General Superintendent of Motive Power of the Chicago, Rock Island & Pacific, has been appointed Superintendent of Motive Power of the Delaware, Lackawanna & Western, succeeding R. F. Kilpatrick, resigned.

Mississippi Central.—T. S. Myers, Division Engineer at Brookhaven, Miss., has been appointed Chief Engineer, with office at Roxie, Miss.

St. Louis & San Francisco.—George A. Hancock, Superintendent of Motive Power, has been appointed General Superintendent of Motive Power, succeeding W. A. Nettleton, resigned to go to the Chicago, Rock Island & Pacific. The office of Superintendent of Motive Power has been abolished.

CAR BUILDING.

The Colorado & Southern is asking prices on 200 steel underframe gondolas.

The Calumet Electric is said to be in the market for 15 cars. This is not yet confirmed.

The Illinois Traction Co. is said to be in the market for 60 cars. This is not yet confirmed.

The Chicago, Milwaukee & St. Paul will build 2,500 freight cars of miscellaneous types at its own shops.

The Northern Pacific, as reported in the *Railroad Gazette* of January 31, is asking prices on 80 passenger cars.

The Duluth, Missabe & Northern is again said to be asking prices on 20 passenger cars. This report is not yet confirmed.

The Canadian Pacific passenger equipment referred to in the *Railroad Gazette* of March 6 is to be equipped with the Gold heating system, with Frumveller heater.

RAILROAD CORPORATION NEWS.

Boston & Maine.—A special meeting of the stockholders of the Fitchburg will be held March 18, to authorize $2,400,000 in bonds to refund $2,000,000 bonds maturing on May 1 and to provide part of the funds for improving the line from Johnsonville, N. Y., to Troy. At the last annual meeting an issue of $2,900,000 bonds was authorized for these same purposes. This is to be rescinded. The amount desired has been reduced by $500,000, as some of the purposes of the large issues have been provided for by the issue of $500,000 one-year notes.

Central of Georgia.—The Georgia Railroad Commission announces that the Central of Georgia is now the property of E. H. Harriman and that it will be turned over to the Illinois Central whose Birmingham extension, described in another column, is nearly finished. In June, 1907, all the $5,000,000 stock of the Central of Georgia was sold by the Richmond Terminal reorganization committee to Oakleigh Thorne and Marsden J. Perry. It now appears that they were acting as agents for Mr. Harriman, for which service they received 5 per cent. on $3,000,000, the purchase price. The announcement of Mr. Harriman's ownership of the Central of Georgia was postponed until the Illinois Central contest was settled by the election at the recent postponed annual meeting of four directors favorable to Mr. Harriman.

Chicago & Milwaukee Electric.—Receivers' certificates up to $1,000,000 are to be issued. The present receivers were appointed on January 28, 1908.

Chicago, Milwaukee & Gary.—This is the new name of the Illinois, Iowa & Minnesota, which runs from Rockford, Ill., to Momence, 125 miles, and with which has been consolidated the Rockford Belt Railway, a small subsidiary. It is planned to extend the line north to Milwaukee and south to Gary, Ind.

Chicago Railways Company.—The National City Bank and N. W. Harris & Co., of New York, who recently offered $2,500,000 first mortgage 5 per cent. bonds of this company at a price to yield 5½ per cent., have offered another $2,500,000 of these bonds, to yield 5⅜ per cent. The first offering was six times oversubscribed. (March 6, 1908, p. 329.)

Chicago, Rock Island & Pacific.—The Chicago, Rock Island & Pacific Railway has arranged with Speyer & Co. for extension of its $6,000,000 two-year 4½ per cent. collateral trust notes which mature April 1, 1908. The extension is for one year with interest at 6 per cent. The extended notes will be secured by $9,000,000 Rock Island, Arkansas & Louisiana first mortgage 4 per cent. bonds, a first lien on 308 miles of road and equipment and the entire amount outstanding. A cash payment of $5 is to be made on each $1,000 note extended, so that there will be a yield of 6½ per cent. on the extended notes. Holders of the old notes who desire cash will receive it in exchange for their notes. Speyer & Co. are offering the extended notes at 99½ and interest, yielding 6½ per cent.

Detroit, Toledo & Ironton.—The lien of the receiver's certificates is junior to that of the Detroit Southern, Ohio Southern division, 4 per cent. bonds of 1941, which cover the middle part of the line and the Detroit, Toledo & Ironton general lien and divisional first mortgage 4 per cent. bonds of 1955, which cover the two ends of the line, from Detroit, Mich., south to Lima, Ohio, 125 miles, and from Ironton, Ohio, north 30 miles.

Erie.—This company is reported to have sold about two weeks ago $1,000,000 Lehigh Valley stock, which it acquired in 1901. Some of its other Lehigh Valley holdings are also reported to have been sold several months ago. Lehigh Valley stock has recently been selling slightly above par.

Gross earnings for January decreased 14 per cent., and net earnings after taxes, decreased 77 per cent. Net earnings after taxes, were $210,000, against $922,000 in 1907.

Great Northern.—Gross earnings for February were $2,841,000, an increase of $184,000, and for the eight months ended February 29, 1908, were $40,800,000, an increase of $5,100,000.

Illinois Central.—There is to be a special stockholders' meeting on May 18 at which the directors will submit a plan for raising between $30,000,000 and $50,000,000; probably by a combined stock and mortgage bond issue.

See Central of Georgia.

Illinois, Iowa & Minnesota.—See Chicago, Milwaukee & Gary.

Interborough Rapid Transit.—Plans for the proposed bond issue (*Railroad Gazette*, March 6, 1908, p. 330) have been changed. The special meeting of the stockholders will be held on March

28, and the new mortgage will secure $55,000,000 of 45-year bonds. The company has applied to the New York City Public Service Commission for authority to make this issue, also to issue $25,000,000 notes dated May 1, 1908, payable within three years with interest at not more than 6 per cent., these notes to be secured by not more than $30,000,000 of the new mortgage bonds.

INTERNATIONAL & GREAT NORTHERN.—Gross earnings for the week ended February 29, 1908, were $152,000, against $216,000 in 1907, a decrease of $64,000, or 30 per cent.

MOBILE & OHIO.—This company has issued $600,000 first mortgage three-year 5 per cent. notes dated February 15, 1908, secured by $603,000 first mortgage bonds of the Warrior Southern guaranteed by the Mobile & Ohio, and $145,000 equipment trust notes of the Warrior Southern, as well as real estate.

NEW YORK, NEW HAVEN & HARTFORD.—President Mellen, answering an inquiry of the New York City Public Service Commission, says that work is not being carried out on the New York, Westchester & Boston because of a cloud on the validity of this franchise, and is not being carried out on the New York & Port Chester because consent of the Board of Estimate and Apportionment to cross certain streets is lacking. The two companies together have all the necessary authority for building the line, but neither has complete authority separately. Mr. Mellen says that the New Haven will proceed without delay to finish the line as soon as the legal difficulties are settled.

NORFOLK & WESTERN.—Gross earnings for January decreased 25 per cent.; operating expenses decreased 20 per cent., and net earnings decreased 34 per cent. The operating ratio was 67 per cent., against 63 per cent. in 1907.

PORTLAND & SEATTLE.—See Spokane, Portland & Seattle.

SANDY RIVER & RANGELEY LAKES.—This company is a consolidation of the Sandy River Railroad, the Franklin & Megantic, and the Kingfield & Dead River, which together operate about 54 miles of narrow (2 ft.) gage line. The Phillips & Rangeley may also be taken over later. (February 14, 1908, p. 234.)

SOUTHERN PACIFIC.—Gross earnings for January were $9,300,000, against $10,800,000 in 1907, a decrease of $1,500,000, or 14 per cent. Net earnings after taxes were $2,000,000, against $3,500,000, a decrease of $1,500,000, or 43 per cent. The higher price of coal and fuel oil was responsible for $128,000 of the increase; taxes increased $108,000, and renewals of ties $197,000.

SPOKANE, PORTLAND & SEATTLE.—This is the new name of the Portland & Seattle, which is building a low-grade cut-off from Spokane, Wash., via Pasco, to Portland, Ore., for the Great Northern and Northern Pacific. This new line is to be finished from Spokane to Portland this year.

TEXAS & PACIFIC.—Gross earnings for the two months of January and February were $2,500,000, against $3,100,000 in 1907, a decrease of $571,000, or 19 per cent.

UNION PACIFIC.—With 200 more miles operated than in the previous year, gross earnings for January, 1908, were $5,200,000, against $6,000,000 in 1907, a decrease of 13 per cent. Net earnings after taxes were $1,800,000, against $2,800,000 in the earlier year, a decrease of 35 per cent. There was an increase in expenditures for renewal of rails and of ties of $195,000; taxes increased $62,000.

WABASH-PITTSBURGH TERMINAL.—The following is the statement of earnings filed with the Interstate Commerce Commission for the month of January and for the seven months from July 1, 1907, to January 31, 1908, inclusive:

	January.	Seven months
Freight revenue	$49,369	$797,971
Passenger revenue	7,472	80,523
All other revenue from transportation	2,284	15,805
Revenue from operations other than transp...	201	3,396
Total operating revenues	$59,327	$897,700
Maintenance of way and structures	7,679	67,488
Maintenance of equipment	7,679	90,960
Traffic expenses	1,618	11,751
Transportation expenses	19,027	200,343
General expenses	3,554	22,414
Total operating expenses	$38,915	$392,969
Net operating revenues	20,411	506,738
Taxes	5,976	45,716
Operating income	$14,435	$461,021

WESTERN MARYLAND.—Judge Morris in the United States Circuit Court at Baltimore on March 5 appointed President B. F. Bush of this company its receiver. The company was embarrassed by lack of working capital. Its earnings were increasing, gross earnings for the week ended February 29, 1908, being $120,000, against $108,000 in the corresponding week of 1907, and from July 1, 1907, to February 29, 1908, having increased over $500,000, or 15 per cent. The management was also embarrassed by the uncertainty as to the proper procedure under the commodity clause of the Rate Law. The Western Maryland owns large bituminous coal workings.

ANNUAL CONSTRUCTION RECORD.

A

ABERDEEN & TOMBIGBEE.—Building from Okolona, Miss., southeast to Pickenville, Ala., 65 miles; surveyed. Grading finished between Okolona and Aberdeen 17.5 miles, also Columbus to Pickensville, 11.5 miles. W. T. McKee, Chief Engineer, Aberdeen, Miss.

ALASKA CENTRAL.—Building from Seward, north to Tanana river, 450 miles. Contract to Snow & Watson, for 23 miles. Surveyed to mile 183; also for branch from Knik, mile 150, east to Matanuska, 40 miles.

ALASKA PACIFIC.—Building from Martin Island, near Katalla, Alaska, to Bering river coal fields. Surveyed to Copper river valley.

AMERICAN RAILROAD OF PORTO RICO.—Cut-off from Hormigueros south to Lajas, 12 miles, to be finished this month.
——Branch to be built this year from San German, east to Sabana Grande, 9 miles. Includes one large bridge and several smaller structures.

ARIZONA & CALIFORNIA.—See Atchison, Topeka & Santa Fe.

ARKANSAS, LOUISIANA & GULF.—Building from Monroe, La., north to Pine Bluff, Ark., with a 7-mile branch to Crossett, Ark, in all 143 miles. Built from Monroe, La., north to Bastrop, 24 miles, and graded 38 miles further to Hamburg, Ark.; also on the branch to Crossett. Track-laying in progress. The 80-mile further extension from Hamburg to Pine Bluff has been surveyed, and grading is to be begun soon as line is finished to Hamburg. E. T. Bond, Chief Engineer, Bastrop, La.

ARKANSAS, OKLAHOMA & WESTERN.—Surveys being made for extensions from Rogers, Ark., northeast to Eureka Springs, 30 miles, and from Siloam Springs, Ark., west to Pryor Creek, Okla., 65 miles. Contract let for some of the work to the W. R. Felker Construction Co., of Rogers, Ark. Bonds offered in January, 1908, at par by Merriam Smith & Co., of New York.

ASHEVILLE & HENDERSON (Electric).—Surveys being made from Asheville to a point in Henderson county, about 20 miles. C. E. Van Bibber, 60 Wall street, New York, Chief Engineer.

ATCHISON, TOPEKA & SANTA FE.—Building new double-track tunnel through Raton Mountain, near Raton, N. Mex. To be 5,000 ft. long, through solid rock, 144 ft. below the existing tunnel. Work 70 per cent. finished. The Lantry Construction Co., Kansas City, Mo., contractors.
——Contracts let to A. Moore, of Newton, Kan., for reconstructing 14 miles of road from Shattuck, Okla., west towards Higgins, Tex.
——Contracts let for change of line and grades, Belle Plaine, Kan., southwest to Cimarron river, near Waynoka, Okla., to the C. H. Sharp Con. Co. and L. J. Smith, of Kansas City, Mo., S. Dolman & Son, Topeka, Kan., and Wood, Bancroft & Doty, Omaha, Neb.
——Contracts let to Wood, Bancroft & Doty, Omaha, Neb., and Dolman & Son, Topeka, Kan., for rebuilding the line from Cicero, Kan., to Mayfield, and for enlarging the yards at Wellington.
——The Southern Kansas of Texas, permitted to take up the track on the Panhandle Railway from a point 1.25 miles west of Panhandle, Tex., to Washburn, 14.3 miles, and to build a new line from the point 1.25 miles west of Panhandle to Amarillo, 25 miles. Work finished on 75 per cent. Wood, Bancroft & Doty, Omaha, Neb., contractors.
——Contract let to Ransom & Cook for grading new yards at Chanute, Kan.
——The Arizona & California projected from Wickenburg, Ariz., on Santa Fe, Prescott & Phoenix, west to Bengal, Cal., on main line, 205 miles. In operation from Wickenburg west 113 miles to the Colorado river. Work under way on bridge over Colorado river and northwest across the Mohave desert to Bengal.
——Projected connecting line shown on map in 1907 annual report from Texico, N. Mex., the eastern end of the Belen cut-off, southeast via Plainview, Tex., Floydada, Dickens, Aspermont, Hamlin, Anson and Abilene, to Brownwood, Tex., on San Angelo branch of Gulf, Colorado & Santa Fe, about 300 miles. This would give the Santa Fe a short through line from San Francisco to Galveston. Not likely to be built for some time.
——See Gulf, Colorado & Santa Fe.

ATLANTA & ST. ANDREWS BAY.—Building an extension from Youngstown, Fla., south to Panama City, 25 miles.

ATLANTA, BIRMINGHAM & ATLANTIC.—Work under way on extension of main line from Talladega, Ala., west to Birmingham, 75 miles. Graded for about 65 miles, and on branch from Bessemer, Ala., to Mulgay, 14.5 miles. Lane Bros. Co., Atlanta, Ga., and C. D. Smith & Co., Birmingham, Ala., contractors.
——Surveys are being made from Atlanta, Ga., southwest to New Orleans, 500 miles.

ATLANTIC COAST LINE.—Contracts let to Wade & Bell, Trinity, Fla.; Wade & Morrison, Washington, N. C., and Phillips & Allport, Richmond, Va., for building extension from Wilcox, Fla., northwest to Perry, 55 miles, for a change of line at Goldsboro, N. C., 4 miles, and a change of line at St. Mary's river, Fla., 1.5 miles. Surveys being made for a change of line 4 miles long at Inverness, Fla.

ATLANTIC, NORTHERN & SOUTHERN.—Built last year between Atlantic, Iowa, and Kimballton, 17 miles. Extensions to be built this year north from Kimballton to Manning, 20 miles, and south from Atlantic to Villisca, 40 miles. C. B. Judd, Chief Engineer, Atlantic.

B

BAKERSFIELD & VENTURA (Electric).—Building from San Francisco, Cal., southeast via Santa Paula, thence southwest to Ventura, on the Pacific coast, with franchises from Sunset northeast to Bakersfield, and from Saticoy south to Hueneme, on the Pacific coast, a total of 370 miles. Branch also projected from Santa Paula southeast to Santa Monica, thence east to Los Angeles, 50 miles. The work will include several tunnels and eight or ten bridges; 20 miles finished. T. B. Blackburn, Ch. Engr., Los Angeles, Cal.

BALTIMORE & OHIO.—Plans for a freight line to be built under charter of the Patapsco & Susquehanna, around Baltimore, Md., 40 miles. The Maryland Court of Appeals has decided that the legislation enacted in 1906 to prohibit building this line is ineffective.

BANGOR & AROOSTOOK.—The annual report for year ended June 30, 1907, includes a map showing a line projected north from the main line at Seboois, Me., along the east bank of the Allagash river to St. Francis, 140 miles. Surveys made over the most difficult parts.

BAY POINT & CLAYTON.—Building from Bay Point, Cal., southeast to Clayton. Finished to Cowell, 10 miles. W. H. George, Secretary and General Manager, San Francisco.

BEAUMONT & SARATOGA TRANSPORTATION.—Building extension from Sour Lake Junction, Tex., to Saratoga, 13 miles. Projected 15 miles further to Batson.

BESSEMER & LAKE ERIE.—Extension of the Western Allegheny located from Kaylor, Pa., northeast to Reidsburg, on the projected Franklin & Clearfield line of the Lake Shore & Michigan Southern.
——About 42 miles of track to be laid, to finish double tracking between Conneaut Harbor, Ohio, and North Bessemer, Pa.

BIG STONY.—See Norfolk & Western.

BILLINGS & NORTHERN.—See Great Northern.

BIRMINGHAM, COLUMBUS & ST. ANDREWS BAY.—Contracts let to Lemuel E. Miller, Philadelphia, for building from Green Head, Fla., to St. Andrews Bay, 38 miles. Grading under way by J. M. Willis, from Sodom to Taylers, 10 miles.
——Surveys for an extension from northern terminus at Chipley, Fla., to Enterprise, Ala., 100 miles. W. M. Gordon, Pres., Columbus, Ga.

BOSTON & ALBANY.—See New York Central & Hudson River.

BOSTON & MAINE.—Plans being made to abolish 19 grade crossings between Johnsonville, N. Y., and Troy.

BOSTON ELEVATED.—Work on the Cambridge subway postponed, awaiting a court decision on question raised by the Mayor of Cambridge. Plans approved and land bought on the East Cambridge elevated extension, including the section in Boston, the viaduct over Charles river and the connections with surface tracks in Cambridge.
——Surveys under way for a subway from Sullivan square, Charleston, to Malden, about 3 miles.
——Permission granted by city and by property owners for subway from point near Park street station of present subway, west under Boston Common to south bank of Charles river, and under Charlesbank to beyond Harvard bridge. To be used by trolley cars for Newton, Brighton, Allston and other outlying points. Work not to be begun for some months yet.

BRINSON RAILWAY.—To build in 1908 from Springfield, Ga., northwest to Sylvania, 32 miles. Last year built 25 miles from Savannah, Ga., north to Springfield.

BROOKLYN RAPID TRANSIT.—Plans made for Flatbush avenue extension to the Manhattan bridge. This work, including third and fourth tracking of other lines, to cost $8,600,000.

BROOKVILLE & MAHONING.—See Pittsburgh, Shawmut & Northern.

BUFFALO & DEPEW (Electric).—See Buffalo, Genesee & Rochester.

BUFFALO & SUSQUEHANNA.—Plans made to rebuild parts of this road south from Juneau Junction southwest to Sagamore, 23 miles. Proposed extension from Sagamore southwest toward Pittsburgh. Surveyed to Southbend.

BUFFALO CREEK & GAULEY.—Extension surveyed from Cresmont, W. Va., to Camden-on-Gauley, 40 miles. Wm. D. Janney, Ch. Engr., Clay, W. Va.

BUFFALO, GENESEE & ROCHESTER (Electric).—Certificate of necessity granted for double track line from Depew, N. Y., to Rochester, 60 miles. Will also take over the Buffalo & Depew, now in operation. The road will run through the towns and villages of Lancaster, Crittenden, Corfu, Batavia, LeRoy and Chili. Henry H. Kingston, J. J. Collier, J. A. Harris, Jr., S. Welch and T. H. Dixon, of Philadelphia; W. B. Cutler, J. H. Baker and H. P. Bissell, of Buffalo, are interested.

BUFFALO, LOCKPORT & ROCHESTER (Electric).—Work under way from Rochester west to Lockport, 54 miles. Contract let to J. G. White & Co., New York. From Lockport the company expects to use the tracks of the International Traction Co. into Buffalo. Chas. B. Hill, President, Elliott square, Buffalo, N. Y.

BUFFALO, ROCHESTER & PITTSBURGH.—Ten-mile section from Carman, Pa., south to Brockwayville, to be revised and a double-track tunnel about 1,000 ft. long, built. Contracts for grading let to Eyre-Shoemaker & Co., of Philadelphia.

BURRS FERRY, BROWNDEL & CHESTER.—Projected from Chester, Tex., east to Louisiana State line at Burr's Ferry, on Sabine river, 85 miles. Surveyed from Rockland to Burkville, 56 miles, graded for 29 miles, track laid on 11 miles. There will be a 200-ft. steel bridge over the Angelina river. Grading finished last year on 21 miles by the Wormack Construction Co., of Browndel. Work suspended. S. G. Omohundro, Ch. Engr., Beaumont.

C

CAIRO & KANAWHA VALLEY.—Proposed extension from Macfarlan, W. Va., to Smithville, 8 miles. Work to begin as soon as bonds can be sold.

CAIRO & THEBES.—Building from Cairo, Ill., northwest to Thebes, 25 miles. J. B. Magee, President. J. L. Armstrong, Ch. Engr., Cairo.

CAROLINA & TENNESSEE SOUTHERN.—See Southern.

CAROLINA VALLEY.—Building extension from Thomasville, N. C., to High Point, 6 miles, and from High Point to Greensboro, 16 miles; two miles built last year; also from High Point to Winston-Salem, 21 miles.

CENTRAL CALIFORNIA.—See Southern Pacific.

CENTRALIA EASTERN.—Contract let to W. F. Nelson, of Seattle, Wash., to build from Centralia, Wash., northeast 9 miles. Grading to be begun at once. Contracts for 5 miles additional may soon be let. B. A. Johnson, Ch. Engr., Centralia.

CHARLESTON & SUMMERVILLE (Electric).—Contract let to the General Contracting & Engineering Co., New York, to build from Charleston, S. C., northwest to Summerville, 27 miles. Grading finished on 23 miles. Julius G. Hocke, President, New York; George Tupper, Secretary-Treasurer, Summerville, S. C. W. O. Sprigg, Ch. Engr., 15 Whitehall street, New York.

CHARLESTON, PARKERSBURG & WESTERN.—Track laid for 30 miles on the line building from Charleston, W. Va., north to Parkersburg, 60 miles. Engineering work under way on the rest of the line, but undecided when grading will be begun. C. P. Peyton, Ch. Engr., Charleston.

CHARLOTTE HARBOR & NORTHERN.—Last year built 37 miles in Florida. Building with its own men a 3-mile line known as the Hull cut-off to Hoist No. 7. Extension from Arcadia to Plant City, 60 miles, surveyed.

CHATTAHOOCHEE VALLEY.—Plans filed for extension from West Point, Ga., north through Troup county, Ga., to Standing Rock, in Chambers county, Ala., thence to a point near Texas in Heard county, Ga.

CHESAPEAKE & OHIO.—The Raleigh & Southwestern, building from the Piney branch at Raleigh, W. Va., up the Piney river and over the divide, thence down the tributaries of the Guyandotte river in Raleigh or Wyoming counties; also extension from Raleigh up Beaver creek into the Glade creek valley. Johnson & Briggs, Richmond, Va., contractors. Work suspended July 1, 1907, on all but 2 miles, which is now under construction on Piney creek above the mouth of Soak creek, Raleigh county.
——Contracts for extending the Coal River Railway let to Carpenter, Haley & Co., of Clifton Forge, Va., for work on Little Coal branch from Rock creek, W. Va., to mouth of Laurel Fork, 17 miles; Laurel to Seng Camp, 5 miles; Laurel to point 5 miles up Laurel Fork. On Big Coal branch to J. C. Carpenter & Co., Dartmouth, to Racine, 8.5 miles.
——Double-tracking work on 67.8 miles at various points, and a change of line on 6.4 miles between Norge, Va., and Diascund, which had been temporarily abandoned, was resumed last fall on certain sections that were nearly finished.
——Extension of the Potts Creek branch, 25 miles; work stopped July 1, 1907.

CHESTERFIELD & LANCASTER.—Recently finished line from Ruby, S. C., to Croburk. Extension projected from Croburk north to Monroe or Charlotte, N. C., 20 to 40 miles.

CHICAGO & MILWAUKEE (Electric).—Grading under way by the MacArthur Bros. Co. on last 8 miles north to Milwaukee, Wis. The company is in the hands of receivers, but hopes to have 23.5 miles double track line from Chicago to Milwaukee finished by May. Republic Construction Co., contractors. F. J. Geraghty, Ch. Engr., Highwood, Ill.

CHICAGO & NORTH-WESTERN.—Work under way on track elevation and a new passenger station in Chicago.

CHICAGO & WABASH VALLEY.—Building an extension from Dinwiddie, Ind., north to Gary, 20 miles.

CHICAGO, BURLINGTON & QUINCY.—Contracts let last year to the Kilpatrick Bros. & Collins Construction Co., of Beatrice, Neb., for new line to reduce grades from Lincoln, Neb., including new yard at that place west to Milford, 20 miles. Work suspended.

CHICAGO, INDIANAPOLIS & EVANSVILLE.—Contract let to the Carter Construction Co. to build from Indiana Harbor, Ind., south through Indianapolis to Evansville, 346 miles. Branch from Logansport, Ind., north to South Bend, 70 miles, projected. W. M. Kenefick & Co., of Kansas City, are the financial backers. William Kenefick, President; J. B. Carter, Vice-President; C. A. Dunneen, Secretary, and R. Zenkere, Treasurer, Indianapolis, Ind.

CHICAGO, LAKE SHORE & SOUTH BEND (Electric).—Building from South Bend, Ind., west to Chicago, Ill., 71 miles; track laid on 48 miles. Grading finished on 13 miles additional. Seven bridges finished and two being built. It is expected to have the entire line in operation by July. J. B. Hanna, President, South Bend.

CHICAGO, MILWAUKEE & ST. PAUL.—Extension from Glenham, S. Dak., west via Butte, Mont., to Seattle, Wash., 1,372 miles, with a branch from the main line at Black River Junction south to Tacoma, 20 miles. There will be 7 steel bridges aggregating 5,725 ft., with steel approaches 3,425 ft. long; 1,500 ft. of steel trestles; 4 tunnels with a total length of 15,630 ft., and later at Snoqualmie Pass a tunnel about 2 miles long. The line from Glenham to Butte is under contract to McIntosh Bros., of Milwaukee. The Bitter Root tunnel in Montana, and approaches for 2½ miles on each side, are being built by Nelson Bennett, of Tacoma, Wash. The line between the Bitter Root mountains and the coast is under contract to H. C. Henry, of Seattle. All steel bridges and trestles will be erected by the company's men. Track laid on Jan. 1 from Glenham west to Ives, N. Dak., 183 miles, and on 144 miles in Montana, out of 731 to finish the line to Butte. Much grading has been done in the Yellowstone and Musselshell valleys, and sub-contracts have been let. It is expected that construction will be completed to Butte by May of this year, and to the coast by the end of 1908, except for the Bitter Root tunnel.
——Work reported under way elevating tracks on the south side of Milwaukee, at a cost of between $500,000 and $750,000.

CHICAGO, ROCK ISLAND & PACIFIC.—Work nearing completion on 39 miles of new yard tracks in the Kansas City terminals.
——Projected line from Amarillo, Tex., west to Tucumcari, N. Mex., 110 miles. Grading under way from Amarillo west 20 miles, and track laying on this section expected to be finished in May. Nothing to be done at present on the remaining 90 miles.

CHICAGO, SOUTH BEND & NORTHERN INDIANA (Electric).—Contracts to be let soon for extension from South Bend, Ind., west to Laporte, 28 miles.

CIMARRON & NORTHWESTERN.—See St. Louis, Rocky Mountain & Pacific.

CINCINNATI BELT LINE.—Surveys made and right of way being secured for a double-track belt line around Cincinnati, Ohio. E. E. Williamson, Union Trust building, Cincinnati, is interested.

CINCINNATI, BLUFFTON & CHICAGO.—Contracts for work on the southern extension from Portland, Ind., southeast to Versailles, Ohio, 35 miles, expected to be let early this year.

CLARK & ROCHEPORT COAL RAILWAY.—Right of way secured from Clark, Mo., south to Rocheport, 28 miles. Grading to be resumed in May, 15 miles graded last year. James D. Wade, Ch. Engr., St. Louis, Mo.

CLEAR LAKE & SOUTHERN (Electric).—Surveys under way and rights of way being secured for this proposed line from San Pablo bay, Cal., north via Napa, to Lakeport, on Clear lake, 135 miles. Grading to be started this summer. LeGrand Brown, Chief Engineer, 34 Ellis street, San Francisco, Cal.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS.—Surveys being made under charter of the Evansville, Mt. Carmel & Northern from Mt. Carmel, Ill., south to Evansville, Ind., 43 miles.

CLEVELAND SHORT LINE.—Building an 18-mile belt line around Cleveland, Ohio. Located from West Park, 7 miles west of Cleveland southeast to near the Cleveland city limits, thence east and northeast toward Collinwood. In southeast Cleveland the line passes under the main streets; also under the tracks of the Pennsylvania Lines, the Erie and the Wheeling & Lake Erie, through double-track tunnels 40 ft. below the surface. A viaduct 1,980 ft. long will carry it over the Cuyahoga river. There are no grade crossings. The line will furnish interchange facilities between 8 railroads. Work started in May, 1906. Contracts all let; to John Marsch, Cleveland, for grading and masonry, and the King Bridge Co. and the American Bridge Co. for bridges on the section from Rockport to the Cuyahoga river south of Cleveland. Graded for 5 miles and considerable work done on balance. Track laid for 4 miles. H. M. North, Engr. of Con., Cleveland.

COAL RIVER.—See Chesapeake & Ohio.

COAST LINE.—See Southern Pacific.

COLORADO & SOUTHERN.—Terminals being built by the Galveston Terminal Co. at Galveston, Tex., at a cost of $5,000,000; $850,000 has already been spent filling in and putting up a freight house. Over 40 miles of track have been laid.

COLORADO SOUTHERN, NEW ORLEANS & PACIFIC.—See St. Louis & San Francisco.

COLUMBUS, MAGNETIC SPRINGS & NORTHERN.—Consolidation of the Delaware & Magnetic Springs and the Richwood & Magnetic Springs, operating 18 miles from Delaware, Ohio, via Magnetic Springs to Richwood, of which 5 miles built last year. Extension to be built from Richwood north to La Rue, 12 miles. W. M. Galbraith, President; C. Magee, Vice-President and Treasurer, Pittsburgh, Pa.; H. E. Buck, Secretary, Delaware, Ohio.

COPPER RIVER & NORTHWESTERN.—Building from tidewater at Katalla, Alaska, through Copper river valley to the interior of Alaska, about 500 miles. A breakwater about 1 mile long will be built at Katalla. Contract let to M. J. Henry for some of the work. This road is one of the J. P. Morgan and Guggenheim projects in Alaska, and will be built by the Katalla Co. M. K. Rogers, President and General Manager, Seattle, Wash.; John Krey, Ch. Engr., Katalla, Alaska.

CORVALLIS & ALSEA RIVER.—Building logging road from Corvallis, Ore., southwest to Alsea river 25 miles; 13 miles graded; track being laid. Stephen Carver, President, Corvallis.

CUMBERLAND RAILROAD.—Contracts let to S. P. Condon, of Knoxville, Tenn., for extension from Artemus, Knox county, Ky., south to Jellico, Tenn., 32½ miles. Track laid from Artemus to Cumberland, 8.2 miles. B. C. Milner, Ch. Engr., Warren, Ky.

CUMBERLAND RIVER & NASHVILLE.—Contracts let to the Monticello Construction Co., of Monticello, Ky., to build from Burnside, Ky., southwest to Monticello, 20 miles; graded for 12 miles, and foundations being built for South Fork bridge. Projected from Corbin, Ky., west to Burnside, and thence southwest to the Tennessee State line, 100 miles, and from this point under the name of the Nashville & Northeastern to Clarksville, Tenn., 60 miles. S. Woodward, President, Carlisle building, Cincinnati, Ohio.

D

DANBURY & PORTCHESTER.—See New York, New Haven & Hartford.

DAYTON, LEBANON & CINCINNATI RAILROAD & TERMINAL CO.—Work to be begun this year on an extension of the Dayton branch from Lambeth, Ohio, west to the union station in Dayton, 1.9 miles.

DEEPWATER.—See Virginian Railway.

DELAWARE & EASTERN.—Proposed northern extension to be built by the Schenectady & Margaretsville from Arkville, N. Y., to Schenectady, 70 miles.

——Proposed southern extension to be built by the Hancock & East Branch from East Branch, N. Y., southwest to Wilkesbarre, Pa., 160 miles.

DELAWARE & HUDSON.—Contract let to O'Brien & Mularkey, of Montreal, for extending the Quebec, Montreal & Southern from Pierreville, Que., to St. Jean des Chaillons, 48½ miles, toward Quebec. About three-fourths of the rails are on the ground and sub-structures of the bridges at Nicolet, Becancourt and East Gentilly and for several smaller structures are about finished. Contracts for 41 miles more soon to be let.

DELAWARE, LACKAWANNA & WESTERN.—Work under way on double track tunnel through Bergen Hill, N. J., to parallel the present tunnel at 51½ ft. between centers.

——Surveys made for a main line cut-off from Port Morris, Morris county, N. J., west through Warren county to Slateford, Pa., on the Delaware river, 28.7 miles. Will save 11½ miles of distance, and have lighter grades and curves and no tunnels of which there are two on the present line. Will take three years to build. Contracts to be let in the near future.

DENVER & RIO GRANDE.—Double-tracking from Florence, Colo., west to Canyon City, 8 miles.

DENVER NORTH-WESTERN & PACIFIC.—Contract let to the Denver-Steamboat Springs Construction Co., recently incorporated in Colorado with capital of $1,500,000, to extend this line from Yarmony, Colo., west to Steamboat Springs, 68 miles. Col. D. C. Dodge is president of the construction company. The line is being built from Denver, Colo., west to Salt Lake City, Utah, 490 miles. In operation from Denver to Yarmony, 147 miles, leaving 343 miles to finish the line to Salt Lake City.

DETROIT RIVER TUNNEL.—See Michigan Central.

DULUTH & NORTHERN MINNESOTA.—Surveys being made in Minnesota for an extension from mile 50 north to mile 170.

E

EAST SIDE VIADUCT.—Incorporated to build an elevated railroad from the terminus of the Harlem river branch of the New York, New Haven & Hartford at Willis avenue in the borough of the Bronx, New York City, southward across the Harlem river and thence between First avenue and Avenue A to East 34th street, Manhattan. Proposed to build a six-track steel and concrete viaduct between Avenue A and First avenue and across Jefferson Park. "The only work has been topographical examinations, plans, profiles, maps, estimates of cost of lines of location and comparison of their totals." O. W. Barnes, Fishkill, N. Y.; C. H. Cooke, O. B. Mairs and William B. Dinsmore, Jr., of New York, and Thomas H. Loomis, of Steubenville, Ohio, directors.

ERIE.—Improvement work under way on Jersey City terminal. The plans provide for a four-track open cut 70 ft. deep and 4,500 ft. long through Bergen Hill for passenger trains. The tracks will run on an elevation in the city east of the tunnel to a new station. The present tunnel will be used for freight trains. The company has bought a large tract of land at the western end of the tunnel, and the city has vacated five blocks on the meadows. The work includes excavating about 120,000 cu. yds. of earth and 480,000 cu. yds. of rock, and building 15,000 cu. yds. of concrete masonry. The Penhorn Creek Railroad incorporated to build this line, 4.74 miles. Contract let to the Millard Construction Co., Philadelphia, Pa.

——Work under way on extension of Penhorn Creek Railroad to New York & Greenwood Lake Railway, 1.16 miles; also under the name of the Newark & Hudson Railroad, a connecting line from this extension to the Newark branch, 1.95 miles.

——Work under way on 34 miles of the Guymard cut-off (Erie & Jersey) building from Howells, N. Y., to Guymard, 42 miles. Contract let to Bennett & Talbot, of Greensburg, Pa., for building the first section of 12 miles, including a 5,300-ft. double-track tunnel through the Shawangunk mountains. Additional contracts let between Highland Mills and Guymard as follows: Newburg Junction to Woodbury, Sundstrum & Stratton, New York; Woodbury to Moodna Creek, John F. Shields, Richmond Hill, Long Island; Moodna Creek viaduct, steel work is being done by the company's forces, masonry work by Smith-McCormick Co., Belfast, N. Y.; Moodna Creek to Otterkill, Ferguson Contracting Co., New York City; Otterkill to Stony Ford, Lathrop, Shea & Henwood Co., Scranton, Pa.; Stony Ford to Howells, F. M. Clement & Co., Philadelphia, Pa. Four miles built last year.

——Contracts let and work under way on the Genesee River Railroad from Hunts, N. Y., south to Cuba, 33 miles, as follows: Hunts to Rossburg, Millard Construction Co., Philadelphia, Pa.; Rossburg to Black Creek, W. H. Coverdale & Co., New York; Black Creek to Cuba, Bennett & Smith, Wilkinsburg, Pa.

——Double-tracking from Carrollton, N. Y., to Cuba, 25 miles. Five miles finished; work suspended.

ERIE & JERSEY.—See Erie.

EVANSVILLE, MT. CARMEL & NORTHERN.—See Cleveland, Cincinnati, Chicago & St. Louis.

F

FAIRCHILD & NORTHEASTERN.—Last year built 5 miles. Expects to finish extension to Owen by June, to complete line from Fairchild, Wis., via Greenwood to Owen, 38 miles.

——Building with its own men a yard about 1 mile long at Owen, Wis.

FLORIDA CENTRAL.—In operation from Thomasville, Ga., south to Roddenbery, 13 miles, and from Fanlew, Fla., south to Veren, 12 miles. Work under way from Roddenbery, Ga., south to Fanlew, 34 miles.

FLORIDA EAST COAST.—Building extension from Homestead, Fla., southwest along Florida keys to Key West, 156 miles. Opened for traffic to Knight's Key, 109 miles. From Key West north, track laid on about 15 miles.

FORT WAYNE & SPRINGFIELD (Electric).—Grading to begin in April on an extension from Decatur, Ind., south to Berne, 12 miles.

FRANKLIN & CLEARFIELD.—See Lake Shore & Michigan Southern.

FREEO VALLEY.—Contracts let last year to S. R. Neu, of Princeton, Ark., for extension in Arkansas from mile 22 to mile 26. E. Bower, Gen. Mgr., Eagle Mills, Ark.

G

GALVESTON TERMINAL.—See Colorado & Southern.

GENESEE RIVER.—See Erie.

GEORGIA & FLORIDA.—Projected connecting links aggregating 150 miles between existing lines to complete a through line from Augusta, Ga., to Madison, Fla. Contract let to Schofield & Sons, Philadelphia, for part of the work.

GREAT NORTHERN.—The Billings & Northern building a connecting line between the Great Northern and Montana Central on the north and the Northern Pacific and Burlington on the south. Grading about two-thirds finished from Armington, Mont., to Laurel, 199 miles. Track laid last year on 32 miles.

——Contracts let to extend the Vancouver, Victoria & Eastern from Keremeos, B. C., west to Princeton, 45 miles. J. H. Stewart, of Grand Forks, B. C., reported to have grading contract for 40 miles, and F. P. Howard, of Maroon Valley, B. C., for work near Hedley. Work also under way from the Pacific coast east to meet the line building west from Keremeos and from Cloverdale, B. C., east to Abbotsford, 26.25 miles. The V., V. & E. and the Victoria Ferry & Railway Co. are building a low-grade line from New Westminster, B. C., south to Blaine, Wash. The part of the line from New Westminster, to Olivers, 9.80 miles, is being built by the V., V. & E., and from that place to the international boundary north of Blaine, 11.32 miles, is being built by the V., F. & R.

——Work under way on the Crow's Nest Southern, building a 24-mile extension from Fernie, B. C., north to the mines of the Crow's Nest Pass Coal Co. at Michel, B. C.

——Proposed double-tracking of the mountain district to be begun as soon as surveys are made on the west slope of the Rockies from Summit, Mont., northwest to Whitefish, 68 miles. Much of the line will be rebuilt.

——See Spokane, Portland & Seattle, formerly Portland & Seattle.

GREENVILLE & KNOXVILLE.—Last year built 15 miles north to Marietta, S. C. Building extension from Marietta north to River Falls, 11 miles. Projected from River Falls to the North Carolina state line, 22 miles.

GULF, COLORADO & SANTA FE.—The Texas & Gulf is building from Center, Tex., via Tenaha to Zuber, 21.3 miles. John Scott & Sons, St. Louis, Mo., contractors. Work suspended Feb. 18, 1908.

GUYANDOTTE & TUG RIVER.—See Norfolk & Western.

H

HANCOCK & EAST BRANCH.—See Delaware & Eastern.

HOLSTON RIVER.—See Virginia & Southwestern.

HUDSON & MANHATTAN RAILROAD.—The two tubes of the south tunnel from Jersey City under Hudson river terminating between Cortland and Fulton streets in Manhattan have been driven from the New Jersey side to about the pier head line in New York. The terminal station at Cortland, Fulton and Church streets, New York, under which is the loop terminal of the south tunnel, is nearing completion and the building is to be opened May 1. The station is to be opened by the time the south tunnel is ready for operation. The station at the western terminus of the south tunnel at the Pennsylvania Railroad terminal in Jersey City is about finished. Work under way on the approach to the river tunnel on Railroad avenue and the connecting tunnel under Washington street in Jersey City. The north tunnel from the D., L. & W. station in Hoboken to Morton street, New York, thence northeast to Nineteenth street and Sixth avenue was opened to the public Feb. 25. Extension north to Twenty-third street to be opened shortly, and to the Thirty-third street terminal, later. Work under way in Manhattan on branch from Sixth avenue east under Ninth street to the subway at Astor place.

HUNTINGTON RAILROAD (Electric).—See Long Island.

I

IDAHO & WYOMING.—See Oregon Short Line.

ILLINOIS, IOWA & MINNESOTA.—Final surveys made for extension from Momence, Ill., northeast to Gary, Ind., 42 miles. Work to be begun this year.

ILLINOIS TRACTION SYSTEM.—This system comprises various lines from Danville, Ill., southwest to St. Louis, Mo., having a total of about 530 miles. The projected entrance to St. Louis includes an independent terminal in Venice, also a new bridge over the Mississippi river from Venice to the foot of Salisbury street, St. Louis. Ground secured for yards, terminals and stations at Salisbury street in St. Louis and adjacent to the stock yards at Venice. Work on the bridge piers soon to be begun.

ILWACO RAILWAY & NAVIGATION COMPANY.—See Oregon Railroad & Navigation Company.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—Projected from Logansport, Ind., south to Indianapolis, 66 miles. Surveys made and rights of way for 25 miles and franchises for entering Indianapolis secured. Graded for 2½ miles at Indianapolis. Walter Osmer, Ch. Engr., Logansport, Ind.

INDIAN CREEK VALLEY.—Location surveys made for 10-mile extension from Jones Mills, Pa. C. F. Hood, President, Normalville, Pa.

INTERBOROUGH RAPID TRANSIT (New York City).—Building an elevated line from 230th street on the Broadway division of the subway (on this section an elevated line) to Van Cortland Park, 1 mile; and a subway from Borough Hall, Brooklyn, to Atlantic avenue, .89 mile. The work is being done by the Rapid Transit Subway Construction Co.

——Plans for additional subway tracks north from 96th street and Broadway to 102d street. Work to be begun soon.

INTER-CALIFORNIA.—See Southern Pacific.

INTERIOR & WEST VIRGINIA.—See Norfolk & Western.

INTERSTATE RAILWAY (Electric).—Grading to be begun this spring from St. Joseph, Mo., to Kansas City, 47 miles. Right of way secured. Address Smith H. Bracey, 1606 Tribune building, Chicago.

J

JOPLIN & PITTSBURG (Electric).—General contract let to A. L. Register & Co., of Philadelphia, Pa., to build extension from Pittsburg, Kan., southeast to Joplin, Mo., 25 miles. Track being laid. Another extension building from Scammon west to Mineral, 5½ miles; also one from Joplin for 12 miles. H. F. Coleman, Ch. Engr., Joplin.

JOLIET & SOUTHERN TRACTION.—Built last year 3 miles in Joliet, Ill., and 7 miles from Joliet to New Lenox. Expects to finish work on the Blue Island division this year; also south from Joliet through Ellwood to Wilmington, 16 miles.

K

KANSAS CITY, MEXICO & ORIENT.—Building from Kansas City, Mo., via Wichita, Kan.; Fairview, Okla. T.; Sweetwater and Presidio, Tex., and Chihuahua, Minaca and El Fuerte, Mex., to Topolobampo, on the Pacific coast, in the state of Sinaloa, 1,664 miles. In operation for 714 miles. Track laid in Kansas, 91.45 miles; Oklahoma, 173.86 miles; Texas, 101.87 miles, and Mexico, 357.49 miles, a total of 724.67, leaving 940 miles still to be built. Track is being laid in the United States northeast from Eldorado, Kan., northeast from Benjamin, Tex., southwest from Sweetwater, Tex.; in Mexico west of Falonier on the Chihuahua division, west of Sanchez in the Sierra Madre mountains and east of Hornillos on the Pacific coast division. Contract let to the International Construction Co., of Kansas City, for building 152 miles.

——Rights of way being secured for a branch from Sentinel, Washita county, Okla., southeast to Lawton, 70 miles. Extension from Lawton east to Sulphur, about 100 miles, also projected. Some grading done at Lawton.

——Surveys made to Kerville for a branch from San Angelo, Tex., southeast to San Antonio.

——Branch projected from San Antonio, Tex., south to Del Rio, 180 miles.

——The Kansas City Outer Belt & Electric, which is to be the Kansas City (Mo.) terminal of the K. C. M. & O., building double-track line. Grading, masonry and bridge work finished, except bridge over Missouri river. L. J. Smith, contractor.

KANSAS CITY OUTER BELT & ELECTRIC.—See Kansas City, Mexico & Orient.

KANSAS CITY SOUTHERN.—Building 3-mile cut-off south of Howe, Okla., to reduce grades. Some bridge work. Extensive surveys made last year for other similar work.

KANSAS SOUTHERN & GULF.—Expects to build extension this year from Westmoreland, Kan., to Manhattan, 22 miles, including a 300-ft. bridge over the Blue river. Surveys made for extension from Blaine, Kan., to Falls City, Neb., 65 miles. Grading to be begun about May 1. O. J. Collman, Gen. Mgr., Lincoln, Neb., and J. E. Williams, Ch. Engr., Westmoreland, Kan.

KENTUCKY MIDLAND.—Last year built 8 miles in Kentucky. Contract let to A. B. Wood, of Cottage Grove, Ore., for an extension from Cypress Creek, Ky., to Midland, 5 miles, including 800 ft. tunnel near Midland. Surveys under way from Midland to Madisonville, 13 miles. M. M. Wheeler, Ch. Engr., Central City.

KEWEENAW CENTRAL.—Building branch from Phoenix, Mich., to Eagle River, 2 miles.

L

LAKE ERIE & PITTSBURG.—See Lake Shore & Michigan Southern.

LAKE SHORE & MICHIGAN SOUTHERN.—Projected extension of the Pittsburg & Lake Erie from Youngstown, Ohio, to Lake Erie. Contract let last year by the Lake Erie & Pitts-

burg to Carter Construction Co. from Mill Creek Junction, near Cleveland, southeast to Kent, 26 miles.
——The Franklin & Clearfield projected from Franklin, Penn., southeast to Brookville, 56 miles. Contracts let last year to the Crary Construction Co.; McNally Co.; Ferguson Contracting Co.; Mills Construction Co.; King Bridge Co., and American Bridge Co.

LAKE SUPERIOR & ISHPEMING.—Surveys being made for change of main line through Negaunee, Mich., about 3 miles; also for reducing the grade on a 5-mile branch and to extend this branch 3 miles. The work will be heavy and includes several steel bridges.

LARAMIE, HAHN'S PEAK & PACIFIC.—Contracts about to be let for work on extension from Centennial, Wyo., south to Hebron, Colo., 77 miles. Part of the work is being done by J. F. White and part by the company's men.

LAS VEGAS & TONOPAH.—Preliminary surveys made from Goldfield, Nev., to Tonopah, 16 miles. Last year 74 miles built on extension from Rhyolite to Goldfield.

LIMA & TOLEDO TRACTION.—See Ohio Electric Railway.

LINCOLN NORTHERN.—See Southern Pacific.

LITTLE RIVER.—Contract let to J. W. Anderson & Co., of Townsend, Tenn., for extension from Forks, Tenn., to Trenthams, 15 miles. Six miles finished and 4 miles in operation.

LITTLE ROCK, MAUMELLE & WESTERN.—Surveys being made for 12-mile extension from Douglas, Ark. Last year built 16 miles in Arkansas.

LONG ISLAND.—Final details not yet settled with the city officials about change of line of the Manhattan Beach line, which is part of the Bay Ridge improvement. It will remove, altogether, about 80 grade crossings between Bay Ridge and East New York and between Manhattan Beach Junction and Manhattan Beach. Contract let to Walter H. Gahagan. Work suspended.
——Plans made to eliminate grade crossings at Old West road, Westbury, and New York avenue, Huntington.
——Work started last year on following: Huntington Railroad (electric) from Huntington, N. Y., south to Amityville, 15.75 miles. Includes 3 bridges. Track laid on 7 miles. Surveys on the Babylon extension (electric) from Babylon west to Amityville, 5.82 miles. Jamaica & South Shore branch from Springfield Junction south to Cedarhurst, 3½ miles. All of this work suspended.
——For other work in connection with the Pennsylvania's tunnel extension to Long Island City and the New York Connecting Railroad, see Pennsylvania.

LOUISIANA & PINE BLUFF.—Contracts let to S. R. Neel, of Huttig, Ark., for extension from Dollar Junction, Ark., to New London, 15 miles. Further extension projected from New London to Wilmington, 15 miles.

LOUISVILLE & ATLANTIC.—Contracts let to Mason, Hanger & Coleman, of Richmond, Ky., and to the Canton Bridge Co., of Canton, Ohio, for building 3 miles from Heidelberg, Ky., to Elk City. C. W. Moorman, Engineer Maintenance of Way, Richmond, Ky.

LOUISVILLE & NASHVILLE.—During 1908 second track to be laid from Perth, Ky., to East Bernstadt, 9 miles, and a new double-track line to be built between Pittsburgh and Little Laurel river, 6.80 miles. Also between Frantz and Lynn Camp Creek, 6.50 miles.
——Work under way on the South & North Alabama between Graces, Ala., and Hardy, 17 miles, reducing grades and revising the line. Second track to be added.
——Work under way extending the Pine Mountain Railroad between Clear Fork river, Ky., and Gatliff coal mines, 17 miles; also branch diverging from Yost to Mahan, 2.30 miles.
——The Swan Creek Railway is to be finished to Flanigan, Tenn., this year. Track laid from Mount Pleasant, Tenn., 4 miles, leaving 13½ miles yet to be built.

LOUISIANA WESTERN—See Southern Pacific.

M

MANILA RAILROAD.—Grading started about a year ago on lines on the Island of Luzon, P. I., aggregating 428 miles, to be built by a syndicate formed by Speyer & Co., New York. No contracts to be let for any of the work.

MASSILLON, WOOSTER & MANSFIELD TRACTION.—Contracts let to the Northern Engineering & Construction Co., Cleveland, Ohio, to build from Massillon, Ohio, west to Mansfield, 50 miles. Graded for 4 miles between Smithville and Madisonburg. G. A. Bartholomew, Ch. Engr., 1423 Williamson building, Cleveland.

MEMPHIS & CHATTANOOGA.—See Southern.

MEMPHIS, PARIS & GULF.—Projected from Memphis, Tenn., via Little Rock, Ark., to Paris, Texas, 400 miles. In operation from Nashville, Ark., southwest to Ashdown, 26.9 miles. Extension to be built this summer.

MEXICO, SANTA FE & PERRY TRACTION.—Grading under way from Mexico, Mo., northeast to Perry, 27 miles. J. M. Wolfe, Collinsville, Ill., contractor. About 3 miles graded. Expected that whole line will be in operation about September. Contracts soon to be let for bridges. Extension from Mexico southwest to Columbia projected. S. L. Robison, President and General Manager, Mexico, and C. O. Thon, Ch. Engr.

MICHIGAN CENTRAL.—Detroit River Tunnel Co. building the Michigan Central's new railroad tunnel under the Detroit river between Windsor, Ont., and Detroit, Mich. The length of the underground part of the tunnel will be 1.5 miles, and the distance from surface to surface about 2.5 miles. Contract let to the Butler Brothers, Hoff Co., of New York. Contract calls for the completion of the work by June 1, 1909.

MINNEAPOLIS & RAINY RIVER.—Building with its own forces extension from Big Fork, Minn., north to Second Crossing, 11½ miles. Graded for 10 miles.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—Work under way by Foley, Welch & Stewart, St. Paul, on extension from Brooten, Minn., northeast to Duluth, 189 miles; 49.6 miles built last year.

MISSISSIPPI CENTRAL.—Contract reported let to O. A. Gibson to build 14 miles from Roxie, Miss., east toward Brookhaven.

MISSISSIPPI VALLEY INTERURBAN.—Organized to build from Springfield, Ill., south to Hillsboro, 53 miles, absorbing as part of the line the Springfield Clear Lake & Rochester, building from Springfield to Rochester, 10 miles; also the Sangamon Valley, building from Hillsboro, north 8 miles. J. E. Melick, President, Springfield.

MISSOURI & NORTH ARKANSAS.—Operates 130 miles from Seligman, Mo., southeast to Leslie, Ark. Track-laying just finished on 31½ miles from Woodruff, 9 miles north of Seligman, northwest to Neosho, on the Kansas City Southern, over which the Missouri & North Arkansas has trackage rights to Joplin. The roadbed for 100 miles south of Leslie is being graded by M. C. Burke and L. S. Joseph; 26 miles of track laid and grade ready for 20 miles more. It is expected to finish tracklaying on this section by July. From Kensett, Ark., for 30 miles southeast toward Helena grading contracts let for 14 miles to the Dalhoff Construction Co., of Little Rock, Ark., and the next 15 miles, one-half to the Alabama Construction Co. and one-half to James Dishman. These firms are putting up the embankment across the White and Cache river bottoms. From Cotton Plant to Helena, 55 miles, grading is 80 per cent. done and track material being received. It is the intention to finish the through line from Joplin, Mo., to Helena, Ark., 361 miles, about Oct. 1, 1908.

MISSOURI, OKLAHOMA & GULF.—Building extension from Wagoner, Okla., north to Joplin, Mo., 120 miles, and another from Rose, Okla., south to Denison, Tex., 102 miles.

MISSOURI PACIFIC.—Work under way extending the Springfield Southwestern, from Gulf street through Springfield, Mo., 1.33 miles.
——Track-laying and ballasting under way on 11 miles of yard tracks at Dupo, Ill.; 27 miles finished last year.
——Grading under way for passenger yard west of the new Union station at Little Rock, Ark., which is nearly finished.

MISSOURI SOUTHERN.—Built 4 miles in 1907. Contracts let to the S. H. R. Robinson & Son Contracting Co., of St. Louis, Mo., for extension from Ohlman, Mo., to Bunker, 8 miles. A further extension projected from Bunker to Salem, 20 miles.

MONTANA RAILROAD.—Contract let to Dittner, Bradbury & Co., of Lombard, Mont., for rebuilding from Lombard, Mont., east to Minden, 36 miles. Surveys made from Minden north to Summit, 14 miles.

MOREHEAD & NORTH FORK.—Building with its own men extension from Paragon, Ky., southeast to Redwine, 10 miles.

MORGAN'S LOUISIANA & TEXAS.—See Southern Pacific.

MORGANTOWN & DUNKARD VALLEY (Electric).—The Morgantown Interstate is grading from Morgantown, W. Va., to Star City, 4 miles. The work includes a 600-ft. bridge. W. W. Smith, Secretary and Treasurer, Morgantown.

MORGANTOWN INTERSTATE.—See Morgantown & Dunkard Valley.

MOUNT VERNON & EASTERN.—See New York, New Haven & Hartford.

N

NASHVILLE & NORTHEASTERN.—See Cumberland River and Nashville.

NEBRASKA, KANSAS & SOUTHERN.—Bids are to be asked about May 1 for building this proposed line from Stockton, Kan., southwest to Garden City, 167 miles. Rights of way partly secured. J. C. Hopper, President, Ness City, Kan. Baxter L. Brown, Ch. Engr., St. Louis, Mo.

NEVADA-CALIFORNIA-OREGON.—Building with its own men extension from Likely, Cal., to Alturos, 20 miles. Projected extension from Alturos north to Lakeview, Ore., 60 miles.

NEVADA COUNTY NARROW GAGE.—Work begun last year on cut-off between Colman Station, Cal., and Long Ravine, 3½ miles. Work is being done by the company's men, and includes a steel bridge 190 ft. high and about 800 ft. long, which is to be begun April 1. Graded for 1½ miles and track laid for about three-quarters of a mile.

NEVADA NORTHERN.—Reported plans for extension from Ely, Nev., southwest to Goldfield, about 170 miles.

NEWARK & HUDSON.—See Erie.

NEW ORLEANS GREAT NORTHERN.—Contracts let last year to W. J. Oliver, of Knoxville, Tenn.: Smith & Scott, Memphis, Tenn.; the Worthington Construction Co., of Alabama; E. W. Hanlon, of New Orleans, La., and Shea & Ford, Buffalo, N. Y., for building various sections of this line as follows: May's Creek, Miss., to Jackson, 84 miles; Lawrence Creek, La., to Tylertown, Miss., 23 miles, and Slidell, La., via Mandeville, to Abita Springs, 26 miles. Last year 53 miles built in Mississippi and 42 miles in Louisiana.

NEW YORK & PORTCHESTER.—See New York, New Haven & Hartford.

NEW YORK, AUBURN & LANSING (Electric).—Building from Auburn, N. Y., to Ithaca, 37 miles. All graded and track laid on 30 miles, and on branches 2 miles. Work under way by the Auburn Construction Co. from South Lansing to McKinneys, 4.1 miles. Projected as steam road, but changed to third-rail. H. A. Clarke, Ch. Engr., Auburn, N. Y.

NEW YORK CENTRAL & HUDSON RIVER.—Excavation and masonry work under way by company's men on second section of reconstructed Grand Central terminal in New York. Steel work being erected by Terry & Trench.
——Buffalo grade crossing elimination work; contract let to the Eyre-Shoemaker Co., Inc., of Philadelphia, for grading the middle section, about one-third of the whole. The city of Buffalo has given contract to John Johnson for changes in streets and street construction.
——Large new yard at Gardenville, near Buffalo, N. Y. Work under way; 10 miles of track laid in 1907.
——Tracks in Tenth and Eleventh avenues, New York, to be removed from the surface of the streets. Not yet determined whether they will be elevated or depressed in a subway.
——Elimination of grade crossings on Harlem division in Mount Vernon, N. Y. Grading for new line in progress.
——Proposed elimination of grade crossings on Harlem division at Tuckahoe, N. Y. Plans being considered by village authorities.
——Proposed elimination of grade crossings on Hudson division through Yonkers, Tarrytown and Ossining, N. Y. Necessary before electrification can be extended to South Croton. Some work done, but now suspended.
——Work under way on the Boston & Albany on 14½ miles of third track between Pittsfield, Mass., and Albany, N. Y.

NEW YORK, NEW HAVEN & HARTFORD.—Harlem river branch from Harlem river to New Rochelle, N. Y., now double track, is being six-tracked. Daly & Holbrook, contractors. Four tracks will be equipped electrically with the third-rail system. Estimated cost of entire work, $7,101,891; $4,825,891 for roadway and stations, and $2,286,000 for electrical equipment and apparatus.
——The Providence Terminal Co. building a double track connecting line from the main line station at Providence, R. I., under the river to East Providence, 2.70 miles, including a tunnel under the city. The tunnel is being driven from both ends; about 2,100 ft. have been driven, leaving 2,900 ft. yet to be bored.
——Double-tracking on the Highland division between Waterbury, Conn., and Bristol. Work under way from Waterbury to Terryville Summit, 9 miles, which is expected to be finished early this year, and the rest at the close of the year. This work involves the re-location of much of the line and a 3,500-ft. tunnel at Pequabuck, Litchfield county.
——Widening cut through the city of New Haven for 4 tracks, 1.65 miles. C. B. Blakeslee & Sons, of New Haven, have the contract. Nearly finished.
——Building electric roads from Waterbury, Conn., to Woodbury, 13 miles, and from Waterbury to Thomaston, 6 miles. Work under way.
——Elimination of nine highway crossings at New Bedford, Mass., under way and to be finished in about a year. New engine house and freight yard also to be built.
——Building an extension of the Springfield & Eastern (electric) from Monson, Mass., to Fiskdale, 12 miles; and to South Monson, one-half mile. Palmer to Fiskdale, 11 miles, finished.
——The Danbury & Port Chester is to build a new double track cut-off from the New York division near Greenwich, Conn., via Ridgefield, to Highland division west of Danbury, 30 miles; will shorten distance between New York and Danbury 15 miles. Postponed.
——Negotiations with city of Springfield, Mass., whereby the lands on which the railroad enters Springfield on the east side of the Connecticut river will be sold to the city of Springfield, the tracks transferred to the west side of the river and a new line built from Warehouse Point northward to Springfield, 12 miles. When the change is made trains will run all the way from Hartford to Springfield on the west side of the river. The railroad will build a new bridge over the Connecticut river at Springfield. Under investigation.
——Proposed line from present southern terminus of main line at Woodlawn, 12 miles north of New York, south along the east bank of the Bronx river, 4 miles, to connection with Harlem River & Portchester branch near West Farms, 4 miles north of Harlem river terminus. Investigated only.
——Proposed cut-off from Plantsville, on the Northampton division, southeast to Yalesville on the Hartford division, 8 miles. Investigated only.
——Some work done over a year ago by the New York, Westchester & Boston (electric) from 177th street, New York, north to the city boundary, 4¼ miles. The proposed line is from Harlem river at 129th street, north through West Farms, Westchester, Bay Chester, Pelham Manor, Pelham, New Rochelle, Larchmont, Mamaroneck, Harrison and Rye to Port Chester to the Connecticut line, with branch from Pelham through Mount Vernon, Alameda Park, Fairview Park, Tuckahoe, Arthur Manor and Scarsdale to White Plains, N. Y., in all 38 miles. The New York & Port Chester, which has franchises over nearly same route, is also con-

trolled by the New Haven. No new construction in last year. Mace Moulton, Ch. Engr., 37 Wall street, New York.

——The Mount Vernon & Eastern (Electric) has been incorporated in the interest of the New Haven through the New York, Westchester & Boston, to build from Mount Vernon, N. Y., northeast to Lewisboro, near the Connecticut State line, 35 miles. Preliminary surveys in progress.

——See East Side Viaduct.

NEW YORK CONNECTING.—See Pennsylvania.

NEW YORK, PITTSBURG & CHICAGO AIR LINE.—Surveys being revised for this line. Projected from Pittsburg, Pa., east via Indiana, Cherry Tree, Irvona, Sandy Ridge, Loveville, Tusseyville, New Berlin, Sunbury, Mahanoy City and Tamaqua to Allentown, 298 miles. Joseph Ramsey, Jr., Orange, N. J., is interested. No connection with electric line projected under similar name.

NEW YORK SUBWAYS.—Work under way on a four-track subway loop to connect the Brooklyn and Williamsburg bridges in the Borough of Manhattan. Contracts let on five sections, aggregating $9,094,606 as follows: Bradley Contracting Co., in Centre street between Pearl street and Park Row; Degnon Contracting Co., in Centre street between Pearl and Canal streets, including a spur from Centre street to the Manhattan bridge approach; Cranford Co., in Centre street between Canal and Broome streets; Bradley Contracting Co., in the new extension of Delancey street between Centre street and the Bowery; same company in Centre street between Bowery and Norfolk street. No work has been done on the Brooklyn side.

——The New York State Public Service Commission, First district, has approved the route for the Fourth avenue subway in Brooklyn. It is to be a four-track subway through Flatbush avenue to Fourth avenue, from where a two-track subway will run to Coney Island; also one to Fort Hamilton. Bids will soon be asked for. The estimated cost is $20,000,000.

——The Public Service Commission, First district, has approved plans for the Broadway-Lexington avenue subway from the Battery at the south end of Manhattan Island, north under Church and Vesey streets to Broadway, thence under Broadway and Lexington avenue to the Bronx side of the Harlem river, where it will branch into two spurs, one to Woodlawn Cemetery and the other to Pelham Bay Park. The estimated cost of the work with a line across the island at Canal street, is $67,000,000. The Commission passed a resolution asking the Board of Estimate to assent to the scheme. It is expected that bids will be asked shortly after contracts are let for the Fourth avenue subway.

NEW YORK, WESTCHESTER & BOSTON.—See New York, New Haven & Hartford.

NORFOLK & SOUTHERN.—Contracts let and work under way in North Carolina as follows: Between Farmville and Snow Hill, 10.10 miles; Bayboro and Oriental, 9.80 miles; Mackay's Ferry and Edenton, 9.37 miles; Mackay's Ferry and Columbia, 22.40 miles, and Bishop Cross and Pine Town, 10.95 miles.

NORFOLK & WESTERN.—Work is to be carried out by this company as follows: Extension of the Tug Fork branch, 2.13 miles up the right fork of Sand Lick, in West Virginia; also an extension above Pageton, 4.03 miles. Work under way.

——The Pocahontas & Western to be extended 4 miles in Virginia to the Pocahontas Consolidated collieries.

——The Interior & West Virginia, building from the terminus of extension of Big Stony through Monroe county, W. Va., to Virginia State line, 17½ miles.

——The Virginia & Potts Creek, to be built from the terminus of the Interior & West Virginia to Potts Creek, Va., 11 miles. Work under way to Paint Bank, 4.2 miles.

——The Big Stony started work last year on extension from Interior, Va., to West Virginia State line, 6 miles.

——The Guyandotte & Tug River has secured nearly all the right of way for main line between Clarks Gap, W. Va., and Wharncliffe, 62.27 miles; also located the Barker Creek branch, 10.7 miles, from the mouth of Pinnacle Creek up Guyandotte river, and secured most of the right of way. Extension located to a point on Guyandotte river above the mouth of Slab Fork, 3.03 miles. Branches also located as follows: Pinnacle Creek branch, 7.35 miles, and Still Run branch, 3.56 miles.

NORTHERN DAKOTA.—Grading to be begun in April or May on line from Edinburg, N. Dak., west to a terminal not yet named, about 21 miles. Work expected to be finished by August. Contracts shortly to be let for 60,000 ties. Thomas D. Campbell, President; E. Thorwaldson, Vice-President, and D. F. Bull, Secretary and Treasurer, Edinburg.

NORTHERN OF MAINE.—Grading to be begun about May 1 from Van Buren, Me., west along the northern boundary of Maine via Grand Isle, Madawaska, Frenchville, Fort Kent and St. John to St. Francis, 62 miles. Contracts soon to be let. One bridge. Edson E. Goodrich, President, Waterville, and Henry F. Hill, Ch. Engr.

NORTHERN PACIFIC.—Rebuilding and double-tracking main line from Lake Park, Minn., west to Glyndon, 25 miles. Work 80 per cent. completed and to be finished this spring.

——New alternative line being built from Alta, N. Dak., to Berea, 9.4 miles north of Valley City.

——New track on revised grade being built for westbound trains from Wheatland, N. Dak., to Buffalo, 11.2 miles; the present line will be used for eastbound trains.

——Double-track work between Casselton, N. D., and Wheatland, to be finished this year.

——Second track under construction from west end of Bozeman tunnel to Bozeman, Mont., 11.8 miles. This is expected to be put in operation in 1908.

——Work under way changing the line and grades in connection with new second track between Garrison, Mont., and Missoula, 69.1 miles.

——Alternate line to eliminate mountain grades from St. Regis, Mont., to Paradise, 21.8 miles; this in connection with the proposed line and grade revision between De Smeth and St. Regis, now operated as a branch line, will reduce the eastbound grade to 0.3 per cent. and westbound grade to level between Tunah and Paradise. It is expected to have this finished in 1908.

——On the White Pine Hill line, 28.4 miles, in Montana, work is under way on a change of line to reduce grades.

——In Washington between Kalama and Vancouver second main track work and improving line and grades on 29.9 miles is under way, and is expected to be finished in the fall of 1908.

——See Oregon, Washington & Idaho under Oregon Railroad & Navigation.

——See Spokane, Portland & Seattle, formerly the Portland & Seattle.

NORTHWESTERN.—See Oregon Short Line.

NORTHWESTERN PACIFIC.—Contracts let to Warren Improvement Co., of San Francisco, for Surveys made from Willits, Cal., north 3 miles. Surveys made from Willits north to Shively, 108 miles, on the main line, and from Flodgate south 63 miles, on the branch from Albion to a junction with the main line at Healdsburg.

O

OCEAN SHORE (Electric).—Building double-track line from San Francisco, Cal., south to Santa Cruz, 79.5 miles. Grading 85 per cent. finished. Track laid for 36 miles. J. Downey Harvey, President; Burke Corbet, Secretary; J. B. Rogers, Ch. Engr., San Francisco. In operation from San Francisco to Pedro Valley, 17 miles.

——The Ocean Shore & Eastern to build a branch from Santa Cruz, Cal., southeast to Watsonville, 19 miles. Surveyed.

——The San Joaquin Valley Western to build from Hollister, Cal., to Coalings, 200 miles. Surveyed.

——The San Juan Pacific to build from Watsonville, Cal., to Hollister, 25 miles. Surveyed. In operation for one-third of the distance.

OCEAN SHORE & EASTERN.—See Ocean Shore.

OHIO ELECTRIC RAILWAY.—The Lima & Toledo Traction, building extension from Deshler, Ohio, northeast to Toledo, 30 miles. Reinforced concrete bridge 1,220 ft. long over the Maumee river near Waterville finished. Graded to Toledo city line. Work suspended, to be resumed this spring and finished this summer.

OPELOUSAS, GULF & NORTHEASTERN.—See Texas & Pacific.

OREGON & WASHINGTON.—See Oregon Railroad & Navigation.

OREGON EASTERN.—See Southern Pacific.

OREGON ELECTRIC.—Work finished from Portland, Ore., via Tualitin and Wilsonville to Salem, 50 miles, except ballasting, which is under way. Extension projected from Portland to Forest Grove, 25 miles. Surveyed. Guy W. Talbert, Manager, Portland.

OREGON RAILROAD & NAVIGATION.—Work under way finishing extensions as follows:

——Between Elgin, Ore., and Joseph, on remaining 56½ miles. Contract for 47 miles let to Erickson & Peterson, of Portland.

——Between St. John and Woodlawn, 1.80 miles.

——On the Oregon, Washington & Idaho, between Riparia, Wash., and Lewiston, Idaho, 37 miles.

——On the Ilwaco Railway & Navigation, between Ilwaco, Wash., and Knappton, 9.40 miles. Erickson & Peterson, Portland, Ore., contractors.

——The Oregon & Washington, projected from Portland, Ore., north to Tacoma and Seattle, 230 miles. At Tacoma there is to be a 8,700-ft. tunnel. Surveyed to Tacoma.

OREGON SHORT LINE.—The Northwestern Railroad projected from Huntington, Ore., north along the Oregon-Idaho State line following the Snake river to Lewiston, Idaho. Contracts let last year to Utah Construction Co., Ogden, Utah, from Blakes Spur north to Homestead, 58 miles; includes 2,200-ft. tunnel east of Huntington. Graded for 25 miles. Work suspended.

——Location surveys made for the Idaho & Wyoming from Elva, Idaho, east to Jackson, Wyo., 105½ miles. Work not yet started.

OREGON WESTERN.—See Southern Pacific.

OWENSBORO & ROCKPORT BRIDGE & TERMINAL CO.—Work expected to be started this year from Owensboro, Ky., north to Rockport, Ind., 12 miles, including a bridge over the Ohio river. A. H. Kennedy, President; G. H. Cox, Secretary, Owensboro.

P

PACIFIC & EASTERN.—Surveys being made for extension from Eagle Point, Ore., to Butte Falls, 21 miles.

PACIFIC & IDAHO NORTHERN.—Surveys being made for extensions from Evergreen, Idaho, east to Roseberry, 35 miles.

PANHANDLE SHORT LINE.—Projected from Dalhart, Tex., south via Hereford and Midland to San Antonio, with a branch from Midland to Rockport on the Gulf. Grading contract let to Miller & Jefferson from Dimmitt south to Lamb county, 60 miles. Grading finished from Hereford to Dimmitt, 32 miles. There will be a number of bridges. Other contracts soon to be let. W. G. Ross, President, and A. D. Goodenough, General Manager, Hereford, Tex.

PATAPSCO & SUSQUEHANNA.—See Baltimore & Ohio.

PAYETTE VALLEY.—Surveys being made for extension from New Plymouth, Idaho, southeast to Falk's Store, 7 miles.

PENHORN CREEK.—See Erie.

PENINSULA RAILWAY (Electric).—Built 8 miles from Bartow, Fla., west to Mulberry, last year. Rights of way secured and 1,000 tons of rails on hand. Expects to begin work soon on remaining 37 miles to Tampa. The Florida Engineering Co. in charge, and W. H. Evers, Bartow, is Ch. Engr.

PENINSULAR RAILROAD.—See Southern Pacific.

PENNSYLVANIA.—Terminal improvements at New York being carried out by the Pennsylvania Tunnel & Terminal Railroad as follows:

——New line from Harrison, N. J., the point east of Newark where the tunnel line leaves the present main line, to the Weehawken shaft of the Hudson river tunnel. Much of the masonry, superstructure and embankment work finished.

——Work being carried on from both ends and from a shaft in the center on two single-track tunnels under Bergen Hill. William Bradley & Sons, contractors. Excavation on tunnels finished, except on 700 ft., and concrete lining being put in.

——Two single-track tube tunnels from Weehawken under Hudson river to 11th avenue shafts; tubes completed and concrete lining being put in. O'Rourke Engineering Construction Co., contractors.

——Western approach to passenger station between 11th avenue and Ninth avenue. New York Contracting Co., contractors. All excavated and work from Ninth and Tenth avenues half finished.

——Contract for construction of the station building and all electrical equipment for the entire terminal and approaches let to Westinghouse, Church, Kerr & Co. Steel work under way on station building.

——Tunnels under 32d and 33d streets, Manhattan, from terminal station at Seventh avenue to East river. United Engineering & Contracting Co., contractors. All excavated except between Fifth and Sixth avenues, and about one-half lining and other work finished.

——Four single-track tubes under the East river, from Manhattan shaft to Long Island. Three of the iron tubes have been joined, and it is expected to connect the fourth by March 20, or earlier. S. Pearson & Son, Ltd., contractors.

——Tube tunnels from river shaft east under Long Island City to East avenue shaft. Excavated, iron lined and two-thirds of concrete lining in place. S. Pearson & Son, Ltd., contractors.

——Tunneling under streets in Long Island City from East avenue shaft to western end of Sunnyside yard, near Thompson avenue; about two-thirds finished.

——Large terminal to be known as the Sunnyside yard, between Jackson and Thompson avenues, Long Island City. To be 5,500 ft. long, 1,550 ft. wide at widest point and include about 400 acres. Work on viaducts, embankments, and bridge masonry under way.

——Franchise granted to the Long Island Railroad for Glendale cut-off between Glendale Junction and Woodside, at the entrance to Sunnyside yard. The cut-off is to be a four-track line. All grade crossings between Jamaica and Woodside will be eliminated.

——Franchise granted the New York Connecting Railroad for line through Brooklyn and Queens boroughs, New York City, and over the East river on a bridge to connection with the New York, New Haven & Hartford at Port Morris on the Harlem river. New line to be built from Manhattan Junction, on Long Island Railroad, to the East river and bridge over the East river and Ward's and Randall's islands, with a connection at Long Island City to the Sunnyside yard. The line is to include on its south end through Brooklyn the Bay Ridge line of the Long Island Railroad from East New York to Bay Ridge, on which improvements are under way to eliminate 115 grade crossings, at a cost of about $7,000,000.

——Work to be started soon on large freight terminal at the Bay Ridge waterfront, Brooklyn. This is to be the western terminus of the New York Connecting Railroad, where cars will be put on boats to be sent to the Pennsylvania yard at Greenville, N. J. Contracts for piers and float bridges let. There is to be a pier 600 ft. long with four tracks. The yard will have a frontage on the upper bay of 565 ft., extending to Fifth avenue between 64th and 65th streets. About 40 tracks, with a capacity of 1,800 cars, are to be laid west of First avenue.

——Terminal yard at Pacific street, Brooklyn, N. Y. Work under way.

——Work under way by the Pennsylvania Railroad on the four-track system on the Middle division, between Vineyard, Pa., and Newton Hamilton. To be finished in May. Revision of line on the Conemaugh division, between Blairsville and Tunnelton, 8 miles, and elimination of grade crossings in Blairsville. Under way and to be finished this summer.

——Eastbound classification yard, at Pitcairn, Pa. Work under way.

——Track elevation on the New Jersey division through Camden, N. J., to eliminate grade cross-

ings between the Delaware river and Cooper's creek. Work under way.
——Track elevation begun on the Kensington branch in the northeastern part of Philadelphia. Contract let to the James McGraw Co.
——On the Monongahela division the Ten-Mile Run branch, from Ellsworth, Pa., to Millsboro, 15.5 miles, has been finished from Ellsworth south 8 miles, and from Millsboro north 1.6 miles.
——Connecting line from Newberry, Pa., along Lycoming creek, from the Erie division to the Elmira division of the Northern Central. Under construction.
——Improvement of grades and curvature between Jersey Shore, Pa., and McElhattan. Under way.
——Proposed relief freight line, to be built under the name of the Pennsylvania & Newark, from West Morrisville, Pa., to Newark, N. J., 50 miles. With its completion, the six-track system will extend from Trenton to Jersey City. Includes new bridge across the Delaware river from Trenton, N. J., to Morrisville.

PENNSYLVANIA ROADS.—The Blair Lumber Co. has given a contract to Vito Greco, of Ligonier, Pa., to build from Laurel Summit, Pa., to Indian Creek, 4 miles. Address J. W. Baker, Ligonier.

PENNSYLVANIA TUNNEL & TERMINAL RAILROAD.—See Pennsylvania.

PHILADELPHIA & READING.—Agreement made with the city of Philadelphia to elevate tracks. Some of the grade elimination work on the Philadelphia, Germantown & Norristown recently let.

PHILADELPHIA RAPID TRANSIT.—Work under way on extension of Market street subway. Contract let to E. E. Smith Contracting Co. from Fifteenth street around the City Hall and east to Juniper street, and to the Millard Construction Co. for eastern section from City Hall loop to Front street. Work from the Delaware river west to City Hall may be finished by July.

PHILIPPINE RAILWAY.—Work under way by the Philippine Railway Construction Co., which has let contract to J. G. White & Co., New York, to build 300 miles of road on the islands of Negros, Panay and Cebu, P. I. William Salomon, Chairman, and Charles M. Swift, President, New York.

PINE MOUNTAIN.—See Louisville & Nashville.

PITTSBURGH & LAKE ERIE.—See Lake Shore & Michigan Southern.

PITTSBURGH, BINGHAMTON & EASTERN.—Building from Binghamton, N. Y., southwest to Clearfield, Pa., 232.5 miles. Grading under way from Renova, Pa., to beyond Westport. Contract let to the Holbrook, Cabot & Rollins Corporation, Boston, Mass. About 21 miles built from Cedar Ledge, Pa., to Powell last year. Other contracts will probably soon be let.
——Branch located and most of the rights of way secured from Cedar Ledge, Pa., to Oregon Hill, 32 miles.

PITTSBURGH, SHAWMUT & NORTHERN.—Work is to be begun in April on extension of the Brookville & Mahoning from Freeport, Pa., to Mahoning, 20 miles.

PITTSBURGH, SUMMERVILLE & CLARION.—Millcreek branch being extended from Millcreek, Pa., 10 miles, by A. Cook's Sons Co., to connect with lumber properties. Four miles built.

POCAHONTAS & WESTERN.—See Norfolk & Western.

PORTLAND & SEATTLE.—The name of this company has been changed to Spokane, Portland & Seattle, which see.

PORT O'CONNOR, RIO GRANDE & NORTHERN. Projected from Port O'Connor, Tex., north to San Antonio, 190 miles, with branches from Gonzales north to Smithville, 50 miles; Yoakum north to La Grange, 61 miles, and Seguin northwest to New Braunfels, 15 miles. At Port O'Connor, the Gulf terminus, it is planned to develop a deepwater port. Graded for 100 miles and track laying soon to be begun. W. S. Hipps & Co., Houston, contractors. L. A. Gueringer, Ch. Engr., Victoria, Tex.

PORTLAND, EUGENE & EASTERN (Electric).—Projected from Portland, Ore., via Eugene to a point in eastern Oregon, about 182 miles. Grading under way from Eugene to Springfield, 6 miles, and track laid in Eugene for 3 miles. The project is financed by A. Welch, of Portland.
——The Salem-Mehama Railway projected from Salem, Ore., southeast to Mehama, 24 miles. Surveys and rights of way secured by Walters Bros., of Salem.

PUBLIC BELT RAILROAD.—Contract let to the Orleans Engineering Co., of New Orleans, for building part of this double-track line around New Orleans, La. Proposed route is from the upper Parish line along the river front to Kentucky street, around the city to upper Parish line, thence along the protection levee to starting point, 22 miles. One track laid from Parish line to Montegut street, 10 miles. W. J. Hardee, City Engineer, is Ch. Engr.; Hampton Reynolds is Assistant Engineer in charge. Work under way on storage tracks and bridges at various points.

Q

QUEBEC, MONTREAL & SOUTHERN.—See Delaware & Hudson.

R

RANDOLPH & CUMBERLAND.—Work temporarily stopped on extension from Hallison, N. C., northeast to Tillman, 3½ miles. Grading finished.

RALEIGH & SOUTHWESTERN.—See Chesapeake & Ohio.

ROBERT LEE, FORT CHADBURNE & EASTERN.—Building from Robert Lee, Tex., northeast to Winters, 35 miles. Work under way from Robert Lee to Rawlings, 13½ miles. Graded for 2¼ miles. J. E. Hunter, Robert Lee, contractor. Additional contracts to be let during first half of 1908. J. Austin Spencer, President, and S. J. Bross, Ch. Engr., Robert Lee.

ROGERS SOUTHWESTERN (Electric).—Building from Siloam Springs, Ark., northeast via Rogers to Eureka Springs, 50 miles. First 27 miles from Siloam Springs finished. Surveys being made on the northern end. Later a line is to be built from a point 7 miles southwest of Eureka Springs south to Huntsville, 22 miles. W. R. Felher, President, Rogers, Ark.

S

ST. JOSEPH, SAVANNAH & NORTHERN.—Located from St. Joseph, Mo., north to Savannah, 15 miles. Work to be begun this spring. T. B. Campbell, M. Tootle and F. J. Wheeler, of St. Joseph, interested.

ST. JOSEPH VALLEY TRACTION.—Building from Middlebury, Ind. east via Shipshewana to La Grange; and, under the name of the St. Joseph Valley Railway, from that point to Angola, 43.7 miles. About finished except some grading, on which work will be resumed this spring. Preliminary surveys made from Middlebury west to South Bend; also from Angola east to Pioneer, Ohio, and Montpelier. G. T. Moore, General Manager.

ST. LOUIS & SAN FRANCISCO.—The Colorado Southern, New Orleans & Pacific, which last year built 121 miles in Louisiana, is putting up a bridge over the Atchafalaya river. This will complete this new line from the Mississippi river to Houston, Tex.

ST. LOUIS, ROCKY MOUNTAIN & PACIFIC.—Surveys reported made for the Cimarron & Northwestern from Cimarron, N. Mex., northwest up the Ponil river to Ponil Park, 22 miles. Grading finished on 15 miles, and 3 miles of track laid. General contract to the Whitescarver Construction Co., Trinidad, Colo., and sub-contracts to Maney Bros., of Oklahoma City, Okla.

ST. LOUIS SOUTHWESTERN.—Three-mile extension under construction at Argenta, Ark.
——Similar terminal extension about 2.75 miles long projected to Fort Worth, Texas.

SACRAMENTO VALLEY & EASTERN.—Building with its own men from Pitt, Cal., to Delamar, 16 miles. Contract for bridge work let to the Globe Construction Co., of San Francisco. Address T. J. Dearborn, Winthrop, Cal.

SALEM-MEHAMA.—See Portland, Eugene & Eastern.

SALT LAKE & OGDEN.—Building extension from Ogden, Utah, city limits to Canyon, 5.60 miles.

SAN ANTONIO & ARANSAS PASS.—Heavier rails being laid from San Antonio, Tex., east to Yoakum, 120 miles; also from Houston west, where 9 miles laid.

SAN DIEGO & ARIZONA.—Location surveys partly made from San Diego, Cal., east to Yuma, Ariz., 200 miles. Small amount of grading done between San Diego and National City; also in the mountains. Over $1,000,000 spent in securing rights of way and terminals in San Diego and National City. The company has taken over the franchises and property of the San Diego Eastern, projected over the same route. John D. Spreckels, San Francisco, is the principal promoter; W. Clagton is Vice-President.

SAN DIEGO EASTERN.—See San Diego & Arizona.

SAN FRANCISCO, IDAHO & MONTANA.—Building, from Caldwell, Idaho, to Homedale, 16.2 miles. Contract let to the Canyon Construction Co., of Caldwell. Graded for 12 miles; tracklaying to be begun in April. Surveys from Homedale, Idaho, to Winnemucca, Nev., 275 miles. F. H. Richardson, Ch. Engr., Caldwell.

SANGAMON VALLEY.—See Mississippi Valley Interurban.

SAN JOAQUIN VALLEY WESTERN.—See Ocean Shore (Electric).

SAN JUAN PACIFIC.—See Ocean Shore (Electric).

SANTA FE, LIBERAL & ENGLEWOOD.—See Santa Fe, Raton & Eastern.

SANTA FE, RATON & EASTERN.—Work resumed in Oklahoma on the Santa Fe, Liberal & Englewood, projected from Des Moines, N. Mex., east via Hooker, Okla., to Woodward, Okla.

SARATOGA & ENCAMPMENT.—Building from Walcott, Wyo., south to Encampment, 45 miles. All graded except yards. Track laid from Walcott to Cow Creek, 34 miles. In operation from Walcott to Saratoga, 24 miles.

SAVANNAH, ANGUSTA & NORTHERN.—Surveys being made from Savannah, Ga., northwest to Chattanooga, Tenn., and east to Augusta, Ga., in all 425 miles. Graded for 58 miles and track laid on 30 miles between Statesboro, Ga., and Garfield. Contracts let to W. J. Oliver, of Knoxville, Tenn. W. H. Lynn, 111 Broadway, New York, interested.

SCHENECTADY & MARGARETSVILLE.—See Delaware & Eastern.

SOUTH & NORTH ALABAMA.—See Louisville & Nashville.

SOUTH & WESTERN.—Building from Elkhorn, Ky., south via St. Paul and Clinchport, Va., Kingsport and Johnson City, Tenn., Spruce Pine, Marion and Bostic, N. C., to Spartanburg, S. C. Work under way from Dante, Va., to Bostic, 211 miles. The Meadows Co., of Johnson City, Tenn., general contractors. Work at various points is being done by Walton, Witten & Graham, of Graham, Va.; Carpenter & Boxley Bros., Clinchport, Va., and Jonesboro, Tenn.; Rinehart & Dennis Co., Washington, D. C.; A. H. Jacoby Co., Clinchport; S. Walton Contracting Co., Falls Mills, Va.; Walton, Wilson, Rodes & Co., Knoxville; Kreis & French Construction Co., Knoxville; J. C. Carpenter & Co., Falls Branch, Tenn.; Carpenter & Boxley, Johnson City; MacArthur Bros. Co., Altapass, N. C.; Patton, Richardson & Co., Marion, N. C.; Purcell, Allen, Sheahan & Co., Thermal City, N. C., and Millard-Quigg Construction Co., Marion. Graded and track laid from Dante, Va., to Bull Run, 16 miles; Johnson City, Tenn., to Blue Ridge Summit, 69 miles; North Cove, N. C., to Marion, 14 miles, and grading 75 per cent. finished on 67 miles more; 75 miles in operation. Heavy work being done to secure a grade of 1.2 per cent. compensated on the east slope of Blue Ridge mountains. There are to be 84 bridges and 33 tunnels. Contracts will probably be let this year from Elkhorn to Dante, 40 miles, and from Bostic to Spartanburg, 33 miles.

SOUTH OMAHA & WESTERN.—See Union Pacific.

SOUTHERN.—Second-track work under way on 33 miles between Motley, Va., and Galveston, expected to be finished by June. About 25 miles in operation between Knoxville, Tenn., and Morristown, and 15 more will be finished by April.
——Similar work between Winesap and Durmid, including a line through the city of Lynchburg, 6.9 miles, is heavy and includes a tunnel 1,300 ft. long. Now suspended.
——Second-track work between Peyton, Ga., and Austell, 11.56 miles, finished with the exception of bridge over Chattahoochee river.
——On the Knoxville division double-track work is nearing completion between Mascot, Tenn., and Jefferson City, 14.3 miles, including a new double-track bridge over the Holston river, and it is expected to have the entire line between Knoxville and New Line ready for operation in May.
——About half the double-track work between Ooltewah Junction, Tenn., and Citico, 13.75 miles, was finished last year; work suspended.
——The Carolina & Tennessee Southern, projected from Bushnell, N. C., west along the northern bank of the Little Tennessee river to the North Carolina-Tennessee State line, 26 miles, is finished from Bushnell for 14.5 miles; work suspended. From the State line further extension under the name of the Tennessee & Carolina Southern to Maryville, Tenn., 38.8 miles; on the latter, grading has been finished for 37.4 miles. Track laid on 4.5 miles. About 25 miles will be ready for operation by July.
——About 150 miles of second track has been finished between Washington and Atlanta, 650 miles; 32 miles more will be put in operation by June.
——The Memphis & Chattanooga projected from Chattanooga, Tenn., to Stevenson, Ala., 42 miles, on which grading and masonry from point near Chattanooga to east portal of Lookout mountain tunnel, about 90 per cent. finished. Work suspended. Work under way lining the double-track tunnel through Lookout mountain, 3,500 ft. long. This is to be finished by July.
——The Louisiana Western building extension from Eunice, La., to Mamon. Graded for 10 miles and work under way on remaining 7 miles.

SOUTHERN KANSAS OF TEXAS.—See Atchison, Topeka & Santa Fe.

SOUTHERN PACIFIC.—Morgan's Louisiana & Texas building extension from Lafayette, La., to Port Allen (opposite Baton Rouge), 21 miles finished, and work on the remaining 32 miles in progress. Extension graded from Bayou Sale to South Bend, 11 miles.
——The Coast Line Railway building north from Santa Cruz, Cal., 12 miles; 9 miles finished and work under way on the remaining 3 miles.
——The Central California, building from Niles, Cal., to Redwood City, 16 miles. Graded for 3 miles and work in progress on rest.
——The Peninsular Railroad building from Mayfield, Cal., to Vasona, 16 miles; 9 miles graded and grading work under way on rest.
——The Inter-California building an extension east from Calexico, Cal., through the northern part of Mexico to Yuma, Ariz., 55 miles. Track laid on 19 miles, and 3 miles more graded. Work under way on remaining 33 miles.
——On the 152 miles projected by the Oregon Eastern, surveys between Natron, Ore., and Klamath Falls, and between the eastern side of the Cascade mountains and Ontario have been finished and considerable right of way secured.
——Oregon Western projected, 82 miles. Surveys made from Drain, Ore., via Marshfield to Ward and considerable right of way secured. Grading and tunneling under way and a large part of steel bridges, rails, ties and other track material bought.
——The Lincoln Northern organized to build from Lincoln, Cal., to Dairy Farm Mine, 11 miles.
——For Mexican Pacific Coast and Cananea, Yaqui River & Pacific, see Southern Pacific under Mexico.

SPOKANE, PORTLAND & SEATTLE.—This road, formerly the Portland & Seattle, is a joint project of the Northern Pacific and Great Northern, to give them a direct low-grade line to Portland, Ore. Building from Portland up the north bank of Columbia river and to Spokane, Wash., with branch east along the Snake river to Texas Ferry,

Wash., a total of 415 miles. From Vancouver, Wash., to Kennewick, opposite Pasco, 220 miles, finished in 1907. Work under way on double-track steel bridges over the Columbia and Willamette rivers. The line between Pasco and Spokane, 145 miles, and the branch to Texas Ferry, 41 miles, also the 10 miles from Vancouver south to Portland is expected to be finished by August. Contract let to Siems & Shields, St. Paul, Minn., from Portland east to Kennewick, 230 miles. N. D. Miller, Ch. Engr., Vancouver, Wash.

SPOKANE & INLAND EMPIRE (Electric).—Last year built 50.5 miles in Washington. Contract let to Grant Smith & Co., of St. Paul, Minn., for extension on the eastern division from Palouse, Wash., south to Moscow, Idaho, 15.5 miles; graded for 14 miles and track laid on one-half mile.

SPRINGFIELD, CLEAR LAKE & ROCHESTER (Electric).—See Mississippi Valley Interurban.

STEPHENVILLE NORTH & SOUTH TEXAS.—Last year built 43 miles from Stephenville, Tex., south to Hamilton. Projected extension from Hamilton, south 60 miles, and from Stephenville, north 38 miles.

SUGAR CREEK & NORTHERN.—See Wheeling & Lake Erie.

SWAN CREEK.—See Louisville & Nashville.

T

TAMPA NORTHERN.—Built 39 miles in Florida last year. Contract let to B. H. Hardaway, of Columbus, Ga., for 9 miles from Envill Junction, Fla., to Brooksville. Surveying from Brooksville north to Thomasville, Ga.

TENNESSEE & CAROLINA SOUTHERN.—See Southern.

TENNESSEE RAILWAY.—Grading recently finished by Walton, Wilson, Rodes & Co. on 17 miles, from a point 2 miles below Smokey creek, Tenn., to Beech fork, on New river, 8½ miles; also on spur along Smokey creek to Asher fork, 8½ miles. Track laid for 7 miles and in progress on remaining 10 miles. A 3-mile spur to be built at once up Straight fork of Smokey creek. The line is being built to develop the coal and timber lands along New river and is eventually to be 75 or 80 miles long. W. O. Dyer, Ch. Engr., Oneida, Tenn.

TEXAS & GULF.—See Gulf, Colorado & Santa Fe.

TEXAS & NEW MEXICO.—Projected from McKinney, Tex., west via Denton, Krum, Bridgeport and Jacksboro, 175 miles. Surveyed for 80 miles, and grading finished on 4 miles. W. J. Healy, Vice-President, McKinney.

TEXAS & PACIFIC.—The Opelousas, Gulf & Northeastern, building from Opelousas, La., northeast to point on the Mississippi and southwest to Gulf. Finished from Melville, La., to Crowley, 58 miles. Myrick & Andrews, Opelousas, contractors.

TEXAS STATE.—In operation from Rusk, Tex., west 10 miles. Building extension west 18 miles to Palestine; extension also projected from Rusk east 6 miles. Plans reported to extend from Palestine northwest to Dallas, Tex., 100 miles, and on the southern end southeast to Sabine Pass, about 160 miles from Rusk.

TOPEKA & NORTHWESTERN.—See Union Pacific.

TOPEKA-SOUTHWESTERN.—Contracts let last year to the Southwestern Construction Co., of Topeka, Kan., from Topeka, Kan., southwest to Council Grove, with a brauch west of Topeka north to the Kansas river, 60 miles. Steel bridge at Dover. W. L. Taylor, President; V. R. Parkhurst, Ch. Engr., Topeka.

TREMONT & GULF.—Building branch from Menefee, La., southeast to Rochelle, 18 miles.

TUSCALOOSA BELT.—Contract let to the Birmingham & Gulf Construction Co., Birmingham, Ala., from Tuscaloosa, Ala., northeast to Gadsden, 120 miles. Eleven miles in operation. Geo. H. Ross, Superintendent, Tuscaloosa.

TWIN CITY & LAKE SUPERIOR (Electric).—Building double track third rail line from Minneapolis and St. Paul, Minn., via Superior, Wis., to Duluth, Minn., 130 miles. Grading contract let from Belt Line, Minneapolis, to St. Croix river, 38.5 miles; graded for 30 miles. Additional contracts for 60 miles to be let April 1. Number of bridges. E. W. Farnham, President; W. H. Crossland, Vice-President. J. H. Thomas, Ch. Engr., Minneapolis.

U

UNION PACIFIC.—The South Omaha & Western is now building a double-track line from South Omaha, Neb., to Lane, 11.60 miles. Four miles finished last year. The Kilpatrick Bros. & Collins Contracting Co., Beatrice, Neb., contractors.

——Contract let to Kilpatrick Bros. & Collins Contracting Co., Beatrice, Neb., to build branch from Rock Springs, Wyo., north to coal fields, 8 miles.

——Contract let to the Kilpatrick Bros. & Collins Contracting Co., Beatrice, Neb., from Luther, Neb., northwest to Northport, 51 miles, on the line from Hershey, Neb., to Northport, 115 miles.

——Extension of the Topeka & Northwestern from Onaga, Kan., to Marysville, 32.44 miles. Kilpatrick Bros. & Collins Contracting Co., contractors. Expected to finish the line by May 1, 1908. To be used in connection with part of the St. Joseph & Grand Island as a through line from Kansas City to main line in Nebraska.

——Contract let to the Kilpatrick Bros. & Collins Contracting Co., Beatrice, Neb., for the Athol Hill cut-off south of Cheyenne, Wyo., from Carr, Colo., northeast to Borie, Wyo., on the main line; also on branch on the main line between Carr and Borie 3 miles south of Corlett, connecting with the Wyoming division 4½ miles west of Cheyenne. Total length of the new lines 17 miles.

UNITED TRACTION CO.—Contract let to A. W. Sykes, of Sykesville, Pa., to build from Sykesville, Pa., to Big Run, 7.5 miles. Grading finished and track laid on 6.5 miles. E. W. Hess, Ch. Engr., Du Bois, Pa.

V

VALLEY RIVER.—Projected from Mill Creek, W. Va., south to Clover Lick, 43 miles; surveys. Work under way from Mill Creek south to Valleyhead. John Alden, Ch. Engr., Elkins, W. Va.

VANDALIA.—Second track and grade reduction work under way from Harmony, Ind., west to East Yard at Terre Haute, 15 miles, including a better line between Seelyville and Brazil, 8 miles. Will be 9 reinforced concrete subways and 2 reinforced concrete bridges for highway traffic, eliminating 11 grade crossings; also 8 reinforced concrete culverts. Contracts let last year to Jones Bros., of Columbus, Ohio. To be finished in April.

——About one mile of second-track being laid between the west end of the Wabash river bridge at Terre Haute and Macksville. To be finished by April.

VIRGINIA & POTTS CREEK.—See Norfolk & Western.

VIRGINIA & SOUTHWESTERN.—Contract let to Callahan Construction Co., of Knoxville, Tenn., for extension from Moccasin Gap, Va., south to the Tennessee State line, 6 miles, thence under the name of the Holston River Railway, southwest to Persia, Tenn., 38 miles. Work started in 1906, partly suspended in October, 1907, and now under way by small forces "at ruling points." All grading and structures 80 per cent. finished.

VIRGINIA AIR LINE.—Building from Lindsay, Va., south to Upper Bremo, 30 miles. Graded for 27 miles, and track laid on 8 miles. Expects to begin operation in July. J. N. H. Cornell & Co., contractors. W. Washabaugh, Ch. Engr., Charlottesville, Va.

VIRGINIAN RAILWAY.—Consolidation of the Tidewater and the Deepwater roads. Building from Norfolk, Va., west through Virginia, 332 miles, and north through West Virginia to Deepwater, 118 miles. Grading finished, except on few cuts between mile 215 near Leesville, Va., and mile 235, east of Roanoke. Track laid on 306 miles. Work under way on large viaducts prevents finishing track-laying. In operation from Norfolk west to Victoria, 125 miles, and from Deepwater south to Matoaka, 80 miles.

W

WALCOTTVILLE & COLDWATER.—Is to build from Walcottville, Mo., to Coldwater, 30 miles, during 1908. O. G. Wales, Kansas City, Mo., interested.

WARREN, JOHNSVILLE & SALINE.—Projected from Warren, Ark., southeast to Longview, 25 miles, with branch southwest to Hermitage. Built from Warren to Fullerton 7 miles; also from Fullerton on the branch 7 miles. Grading under way on 1 mile. Grading to be begun in May on 5 miles from Fullerton south. J. F. Forsyth, General Manager; C. W. Holderbaum, Ch. Engr., Warren.

WASHINGTON, WESTMINSTER & GETTYSBURG.—Projected from Washington, D. C., northeast to Gettysburg, Pa., 90 miles. Built 25 miles last year. Surveys under way on 3 miles in District of Columbia. Grading soon to be resumed. Ira Taylor, New York, contractor.

——Branch projected west to Frederick, Md. Contract for grading and materials agreed upon. Will probably be operated by gasolene motor cars. J. B. Colegrove, President, Washington, D. C. Walter Atlee, Ch. Engr., Baltimore, Md.

WATERLOO, PELLA & SOUTHWESTERN.—Projected from Waterloo, Iowa, southwest to Charlton, 120 miles. Contracts will probably be let this spring. E. A. Harris, Vice-President and General Manager, Pella, Iowa.

WEST CHESTER & WILMINGTON (Electric).—Projected from West Chester, Pa., south to Wilmington, Del., 17 miles. Work to be begun in March. Two bridges. Thomas E. O'Connell, President; C. P. Faucett, Secretary and Treasurer, Delaware Trust building, Wilmington.

WESTERN ALLEGHENY.—See Bessemer & Lake Erie.

WESTERN PACIFIC.—Building from Salt Lake City, Utah, west to Oakland, Cal., 929 miles, of which 122 miles are in Utah, 427 in Nevada and 380 in California. Contracts let to the Utah Construction Co., of Ogden; E. B. & A. L. Stone, of Oakland, Cal., and Maney Bros. & Co., of Winnemucca, Nev. Up to Feb. 20, 1908, grading finished on 620 miles and track laid on 275 miles, including the section from Salt Lake City west to the crossing of the Nevada Northern at Shafter, Nev., and in California from Stockton east 35 miles, and from Marysville east 34 miles. There will be 43 tunnels aggregating 45,342 lineal ft., three of which are to be over a mile long and a fourth over 4,287 ft. Tunnel work about 55 per cent. finished. There are to be 75 steel bridges, a total of 15,535 ft. long; 7 of these have been finished.

WEST TEXAS & NORTHERN.—The West Texas Construction Co. organized to build this line from Stanton on the Texas & Pacific to Lubbock, 110 miles. Fourteen miles graded north from Stanton.

WHEELING & LAKE ERIE.—Considerable amount of double tracking and minor grade and curvature reduction work contemplated; also the completion of the Sugar Creek & Northern, a new cut-off from Bolivar, Ohio, northwest to Orrville, 22 miles, now three-fourths finished. All work suspended.

WICHITA FALLS & NORTHWESTERN SYSTEM.—Building with its own men extension from Olney, Tex., south to Belknap, 14 miles.

WISCONSIN & NORTHERN.—Projected from Menasha, Wis., north 153 miles. In operation for 43 miles. Projected extensions from Menasha to Shawano, 45 miles; Van Ostrand to Crandon, 32 miles, and from junction with the Minneapolis, St. Paul & Sault Ste. Marie, to the northern boundary of Wisconsin, 33 miles. All but 12 miles surveyed. Three miles partly graded from Crandon south.

WISCONSIN CENTRAL.—About 28 miles to be built to finish the line from Ladysmith, Wis., north to Superior. In Duluth, Minn., building about 4½ miles. Contracts let to H. F. Balch, of Rice Lake, Wis., and to Lantry Construction Co., of Duluth.

WOLCOTTVILLE & COLDWATER.—Projected from Wolcottville, Ind., northeast to Coldwater, Mich., 30 miles. Contract let to Panama Construction Co. Grading to be begun in June. O. G. Wales, President, 541 Frisco building, St. Louis, Mo.

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YELLOWSTONE PARK.—To build from Bridger, Mont., southwest to Cook, 125 miles, including branches. Thirty miles in operation. Contracts let last year to Western Development Co., of Belfry, Mont. "Arrangements pending to continue construction." No connection with recently built Oregon Short Line road of same name.

CANADA.

ATLANTIC, QUEBEC & WESTERN.—Built last year from New Carlisle, Que., north to Port Daniel, 20 miles. Contract let to the New Canadian Co., Ltd., of Paspebiac, and work under way from mile 20 to mile 102.

CANADIAN NORTHERN.—Grading finished by Cowan Construction Co. and track laid from Etoimami, Sask., northeast to Pas Mission, Keewatin, 100 miles. The first section of projected line to Fort Churchill on Hudson bay, 425 miles.

——Branch from Dalmeny, Sask., to Coulter, Man., 45 miles; graded from Dalmeny north 24 miles.

——Extension of Rossburn Junction-Rossburn branch, from Rossburn, Man., northwest to western boundary of Manitoba. Track laid from Rossburn to Russell, 25 miles. Further extensions projected, one northwest to Buchanan, Sask., on main line, the other west via Dundurn, on the Q., L. L. & S. to point near western boundary of Saskatchewan.

——Branch projected from Edmonton, Alb., north to Athabasca Landing, 100 miles. In operation to Morinville, 23 miles. Only surveys beyond that point.

——Proposed extension of Thunder Hill branch from Benito, near western boundary of Manitoba, west to proposed Aberdeen-Fenton connecting line. Nothing done in 1907.

——Proposed connecting line from Prince Albert, Sask., southwest to main line at North Battleford. Bridge being built over North Saskatchewan river.

——Projected line from Saskatoon, Sask., southwest to Calgary, 300 miles. Graded for 30 miles. This is to form part of through line between Calgary and Fort Churchill on Hudson bay by connection with the line north from Etiomani, Sask.

——Contract let for rebuilding 8.4 miles of the Qu'Appelle, Long Lake & Saskatchewan, between Lumsden, Sask., and Disley.

——Plans approved for the joint terminals to be built at Main street and Broadway, Winnipeg, by the Canadian Northern and the Grand Trunk Pacific at estimated cost of $3,000,000.

——Improvements reported will be made this year on line between Port Arthur and Winnipeg. About 30 miles of present rails between Atikokan, Ont., and Rainy river to be replaced with 80-lb. rails, and extensive improvements at Fort Frances.

CANADIAN NORTHERN ONTARIO.—Building a 6-mile line to Key Harbor on Georgian Bay to carry iron ore from the Moose mountain deposits.

——Extension from Parry Sound., Ont., northwest to Sudbury and beyond; 111 miles built in 1907 and in operation for freight service to Sudbury. Projected west to the Canadian Northern, at Port Arthur, 600 miles from Sudbury.

——Projected line from Key Inlet, near Sudbury, Ont., east to Ottawa, 350 miles.

——Grading nearly finished last year from Ottawa east to junction with Canadian Northern Quebec at Hawkesbury, 50 miles.

——Contract let last year to Central Contracting Co., Toronto, to build from Nepigon, Ont., north to Lake Nepigon.

CANADIAN NORTHERN QUEBEC.—About 65 miles graded and track laid for 20 miles on extension from Garneau Junction, Que., to Quebec, 84 miles. Work is being pushed to completion. O'Brien & Mullarkey, of Montreal, contractors.

——Charter granted last year for proposed line from Quebec bridge east to Moncton, N. B.

——Proposed line from Moncton, N. B., to Pugwash, N. S., with branch in New Brunswick south to St. John.

CANADIAN PACIFIC.—Work under way on 196 miles to complete the double-tracking from Winnipeg, Man., east to Fort William, 427 miles. Foley, Welch & Stewart, Winnipeg, general contractors. A 400-ft. tunnel at Kilmar.

——Work started last year on the St. Mary's & Western Ontario from Woodstock, Ont., west to Sarnia, 95 miles. Contract let to John E. Webb, of Toronto, from St. Mary's to Embro, 15 miles, including a reinforced concrete subway under the Grand Trunk at St. Mary's; grading finished and track laid on 3 miles. Surveys being made on 74 miles toward Sarnia. J. G. Macklin, Ch. Engr., St. Mary's.

——Second track laid on about 50 miles between Ste. Annes, Que., and Smiths Falls, Ont.; the remaining 58 miles to be finished this year.

——Line from Saskatoon, Sask., west to Wetaskiwin, Alb., 325 miles. Contract let last year to Foley, Welch & Stewart, from Wataskiwin, Alb., east to Battleford, 250 miles. Grading 95 per cent. finished and 97 miles built from Wetaskiwin east and 26 miles west from Saskatoon. Sub-contract reported let to J. D. MacArthur, of Winnipeg.

——Work under way on 37-mile extension of the Yorkton branch from Sheho, Sask., northwest. Projected to Lanigan, 82 miles. Grading 50 per cent. finished.

——Contract let last year to J. T. Hargrave, of Winnipeg, for grading 30 miles on branch from Stoughton, Sask., west to Weyburn, 37 miles. All graded and 12 miles built last year. Projected from Weyburn, Sask., west 100 miles to Range 30, west of the second meridian.

——Building branch from Reston, Man., northwest to Wolseley, Sask., 122 miles; 98 miles built to Kaiser in 1907.

——Reconnoissance for proposed line from Killiam, Alb., northwest to Strathcona, 80 miles.

——Extension of Kootenay Central from Golden, B. C., southeast to Fort Steel or Jaffray, about 180 miles. Contract for grading 10 miles from Golden south let last year to the British Columbia General Contract Co., of Vancouver. Track to be laid by the railroad.

——Projected branch from Moose Jaw, Sask., northwest to Lacombe, Alb., 375 miles. Grading contract from mile 50 to mile 123 let to J. D. MacArthur, Winnipeg, for work from Moose Jaw north via Tuxford to point 30 miles beyond Rutland, 50 miles. Track being laid by the railroad on first 50 miles; finished to Tuxford, 15 miles. Work also under way from Lacombe east 100 miles toward Moose Jaw. Surveyed, and 51 miles in operation to east Stettler, Alb. Foley, Welch & Stewart, contractors.

——Contract let last year to Foley, Welch & Stewart for work on Toronto-Sudbury line from Bolton, Ont., north to Romford, 226 miles; 160 miles built; whole to be finished in June. Ross & Harris, contractors for 40 miles.

——Agreement made with the Northern Colonization Railway to build extension from Nomininque, Que., west to Rapide de L'Original, in Wright district, 34 miles.

——The Walkerton & Lucknow building from Walkerton, Ont., to Proton, 37.5 miles. About 25 miles built.

——On the branch of the Guelph & Goderich from Linwood, Ont., to Listowel, 16 miles, there are 3 miles still to be built. B. Gibson, Toronto, contractor, and P. A. Peterson, Goderich, Ch. Engr.

——Contract reported let to McDonnell & Gzowski, of Vancouver, B. C., for improving the main line grades near Field, B. C. The work includes two new tunnels aggregating about a mile and a half, one on each side of the Kicking Horse river, and two bridges. To cost about $1,500,000. Preliminary work begun.

——Additional work to be carried out this year as follows: Line to Hardisty, Alb., and extension of the Winnipeg Beach line north to Icelandic river. A large amount of bridge work is also to be done in British Columbia; many wooden bridges will be replaced by permanent structures.

——Extension of 4 years granted to complete the Esquimalt & Nanaimo branch from Nanaimo, B. C., west to Alberti, 50 miles. Location work finished. Contract let to John Bright, of Nanaimo, for grading from Wellington to Nanoose bay, 12 miles, and to A. Carmichael for clearing right of way from Nanoose bay to Alberni, 46 miles.

CAPE BRETON.—Surveys under way for extension to be built this spring from St. Peters, N. S., northeast to Louisburg, 31 miles.

CENTRAL ONTARIO.—Contracts let to build extension from Maynooth, Ont., to Lake St. Peter, 8 miles; also from Lake St. Peter to Whitney, 19½ miles.

CROW'S NEST SOUTHERN.—See Great Northern under United States.

ESQUIMAULT & NANAIMO.—See Canadian Pacific.

GRAND TRUNK PACIFIC.—To extend from Moncton, N. B., 3,550 miles across Canada to Prince Rupert, B. C., a new port on Kai En Island, about 25 miles south of Port Simpson. The total length of all the projected lines is 7,900 miles.

——Moncton to Winnipeg, Man., 1,807 miles, called the National Transcontinental, to be built by the Canadian government. Contracts let for 859 miles and bids asked for 365 miles more. Total expenditure to Jan. 28, 1908, $21,364,364. Contracts let last year as follows:

——To Grand Trunk Pacific Construction Co., from Moncton, N. B., west to point near Chipman, N. B., 50 miles.

——To Lyons & White, of Ottawa, from Grand Falls, N. B., west to New Brunswick-Quebec boundary line, 62 miles.

——To M. P. & J. T. Davis, of Ottawa, from point 52.4 miles west of the New Brunswick-Quebec boundary west to southern end of the Quebec bridge, 150 miles.

——To Hogan & McDonald, Montreal, for 150 miles from north end of Quebec bridge, west to La Tuque. Thirty-four miles of track laid in short sections. Over 6,000,000 yds. of earth and 1,000,000 yds. of rock excavation on this stretch, of which part is finished. Sub-contract for 50 miles from Quebec bridge west let to M. T. Davis, Ottawa. Work under way on Cape Rouge viaduct, 3,000 ft. long.

——To Grand Trunk Pacific Construction Co. from La Tuque, Que., west to Weymontachene, 45 miles.

——To Grand Trunk Pacific Construction Co. from point 8 miles west of Abitibi river, east 150 miles. Some of this sublet to J. H. Reynolds Construction Co. Work to be started on this section this spring.

——To J. D. MacArthur, Winnipeg, from junction to Lake Superior branch with main line, west to point a few miles east of Winnipeg, 244 miles. Sub-contracts let to A. Herbert, 20 miles; W. Wardrup, 15 miles; F. W. Smith, 2 miles of rock work; Guy Campbell, Ottawa, rock work, and W. T. Parsons, of Kenora, Ont., 15 miles, including about 1,000,000 yds. of rock excavation. Excavation on this section amounts to over 11,000,000 yds. of earth and 3,500,000 yds. of rock.

——Bids asked up to March 11 for the following sections: District A.—From about 58 miles west of Moncton, N. B., to the crossing of the Intercolonial, at mileage 97.7, a distance of 39.7 miles. From the latter point to the Tobique river, at mileage 165.7, less one mile, 67 miles. From the Tobique river to about 2½ miles west of Grand Falls, N. B., 31.5 miles. District B.—From the Quebec-New Brunswick boundary westerly for 52.4 miles. District D.—From a point about 8 miles west of the Abitibi river crossing in Ontario, west about 100 miles. District E.—From a point 19½ miles west of the crossing of Mud river, near Lake Nepigon, easterly 75 miles.

——The western line, Winnipeg, Man., via Saskatoon, Sask., Edmonton, Alb., and Yellow Head pass to Prince Rupert, 1,750 miles, and the Lake Superior branch east of Winnipeg to Fort William, to be built by Grand Trunk Pacific. All located. Contracts let for 1,108 miles from Winnipeg, Man., west to 120 miles west of Edmonton. Track laid from Portage la Prairie, Man., via Brandon and Touchwood Hills to Saskatoon, 415 miles. Grading finished from Winnipeg to Portage La Prairie. Contracts let last year as follows:

——Lake Superior branch, from Lake Superior Junction southeast to Fort William, 210 miles, to Foley Bros., Larsen & Co. (now Foley, Welch & Stewart), Winnipeg, Man.; 100 miles of track laid.

——To MacDonald-McMillan Construction Co., Winnipeg, from Winnipeg west to Portage la Prairie, 56 miles. Work under way.

——To MacDonald-McMillan Construction Co., Winnipeg, for grading from Portage la Prairie, Man., west to Touchwood Hills, Sask., 275 miles. Finished.

——To Canadian White Co. (J. G. White & Co.), Montreal, from Touchwood Hills to Saskatoon, Sask., 140 miles. Sub-contracts let to M. C. Cance, Rainy River, Ont.; J. H. Armstrong, and S. D. Lake. Finished.

——To Foley Bros., Larsen & Co., Winnipeg, Man., from Saskatoon to Edmonton, Alb., 328 miles. Sub-contracts let to Cash Bros. for work in Alberta near Battle river. Work under way and to be finished this year.

——To Foley Bros., Larsen & Co., Winnipeg, from a point 6 miles east of Edmonton, Alb., to Wolf Creek, 120 miles west. The section will be the most expensive of any of the western lines yet under contract. Work under way. Contracts let for ties to H. A. Calder, $200,000; Carruthers, Round & Co., and McPhee Bros. & Hislop, each $100,000.

——Work under way on 100 miles of main line east from Prince Rupert, B. C., to Kiteselas canyon, which is the junction point between located direct line eastward and located loop line which is to run north along the Skeena river to Hazelton, then southeast to junction with main line again at point 350 miles east of Prince Rupert. The 100-mile section directly east of Prince Rupert includes much rock work, and it is expected will take two years to build, and cost $7,000,000.

——The Grand Trunk Pacific Branch Lines Co., authorized to build branches from the main line as follows:

——From Moncton, N. B., south to St. John; New Brunswick-Quebec boundary west to the St. Lawrence river, near Riviere du Loup, Que.; south to Montreal; from a point further west southeast to Montreal; to Ottawa; to North Bay; from point northeast of Fort William, Ont., southeast to Orilli, Ont.; Winnipeg south to international boundary; Brandon south to international boundary with a west line from Brandon to Regina, and from point on the international boundary in southeastern corner of Saskatchewan northwest to Regina, thence northeast across main line south of Springside, Sask., to Fort Churchill, on Hudson bay; point east of Saskatoon, north to Prince Albert; point near western boundary of Saskatchewan, north to North Battleford; point near eastern boundary of Alberta, southwest to Calgary, thence southeast to international boundary; Fort George, B. C. south to Vancouver; point near Hazelton, B. C., northwest to Dawson, Yukon. Also line from the southeast end to the northwest end of Vancouver Island.

GREAT NORTHERN.—See Great Northern under United States.

GUELPH & GODERICH.—See Canadian Pacific.

INTERCOLONIAL.—Double-tracking under way between Moncton and Halifax. Contract from Moncton to Painsec Junction, 7 miles, let to J. B. McManus Co., Ltd., of Memramcook, N.B.

——Contract let to Willard Kitchen Co., of Fredericton, N. B., for Colton Factory branch from Richmond, N. S., to Kempt Road, Halifax, 1.69 miles. Work under way.

NORTHERN COLONIZATION.—See Canadian Pacific.

ORFORD MOUNTAIN.—Building extension from Mansonville, Que., to North Troy, Vt., 4.5 miles, and from Windsor Mills, Que., to Bromptonville, 9 miles. Both to be finished early this year.

QUEBEC, MONTREAL & SOUTHERN.—See Delaware & Hudson, under United States.

ST. MARY'S & WESTERN ONTARIO.—See Canadian Pacific.

TEMISKAMING & NORTHERN ONTARIO.—Extension of main line from mile post 208 at the Wataybeag river to mile post 251 near Transcontinental Junction, 43 miles. A. R. McDonald, New Liskeard, Ont., and McRae, Chandler & McNeil, Driftwood City, Ont., contractors.

——Branch from Englehart to Charlton, 8 miles; Canadian Construction Co., Montreal, contractors.

——Branch from Cobalt to Kerr Lake, 4 miles; McQuigge & Hunt, Cobalt, Ont., contractors.

——Surveys for branch from Cobalt to Sudbury, 110 miles.

VANCOUVER, VICTORIA & EASTERN.—See Great Northern, under United States.

VICTORIA FERRY & RAILWAY.—See Great Northern, under United States.

WALKERTON & LUCKNOW.—See Canadian Pacific.

MEXICO.

CANANEA, YAQUI RIVER & PACIFIC.—See Southern Pacific, under Mexico.

KANSAS CITY, MEXICO & ORIENT.—See this company under United States.

MEXICAN CENTRAL.—On the Tampico cut-off about 191 miles remain to be built, 50 miles of which (from the Panuco river south) is under contract. The line as located from the city of Mexico to Tampico will be 304 miles long, as against 1,000 miles by the present route. The 142 miles from Tampico to the foot of the plateau, will have a .5 per cent. grade, and on 54 miles the maximum will be 2.5 per cent. with 8 deg. curves.

——Building Manzanillo extension from Tuxpan, Jalisco, to Colima, capital of Colima, 45 miles. Hampson & Smith, Mexico City, contractors. Number of important bridges and 12 tunnels. Much heavy work to be done between Colima and the port of Manzanillo. Connection at Colima with reconstructed line of Mexican National Construction Co. to Manzanillo. Whole extension to be finished this summer.

——Large terminal to be built at Manzanillo. About 1,000 acres of land bought.

MEXICAN PACIFIC COAST.—See Southern Pacific, under Mexico.

MEXICAN WESTERN.—Grading soon to be begun from Gutierrez, Zacatecas, west to Sombrerete, 100 miles. Final surveys made. R. S. Towns, President of the Mexican Western Construction Co., interested. Vinton P. Safford, Gutierrez, Ch. Engr.

MINERAL BELT OF GUANAJUATO.—Contract let to E. J. White, of Guanajuato, to build 40 miles to mines in state of Guanajuato. Heavy work. Graded from Tepetapa, 2 miles. The Guanajuato Development Co., is building the line.

PAN-AMERICAN.—Contract let to H. L. Heintz, of San Geronimo, Oaxaca, to build from Huixtla, Chiapas, to the Guatamala line, 50 miles, including 5 large bridges. Track laid from Tapachula, Chiapas, to San Bineto, 20 miles.

——This company has concessions for main line to Panama through San Salvador and Nicaragua.

——The Pacific, Gulf & Yucatan is a projected branch from Jalisco, Chiapas, to point in state of Yucatan, 660 miles.

PACIFIC, GULF & YUCATAN.—See Pan-American.

PARRAL & DURANGO.—Last year built 3 miles south of Mesa de Sandia, Durango. Work under way on 12 miles from kilometer 75 to Paraje Seco. Contract let to R. M. Dudley, of Mesa de Sandia.

SOUTHERN PACIFIC.—The Cananea, Yaqui River & Pacific is building a branch from Corral, Sonora, north along the Yaqui river. Projected to international boundary, 386 miles. Built to Cumuripa, 41 miles. Grant Bros. Construction Co., Los Angeles, Cal., has contract to Tonichi, 63 miles.

——Work under way on branch from Rio Yaqui, Sonora, north to Nacozari, 108 miles.

——Work under way from Del Rio Sonora, on the Naco-Cananea line, northwest to Nogales, 75 miles.

——The Mexican Pacific Coast building from Navojoa, Sonora, south of Corral on the Cananea, Yaqui River & Pacific, southeast to Guadalajara, Jalisco, 730 miles. About 84 miles finished last year from Navojoa south, and work progressing. The Grant Bros. Construction Co., Los Angeles, Cal., has contracts for some of the work.

ZACATECAS & EASTERN.—Projected from Camacho, Zacatecas, via Tesolate and Cedros to Bonanzo, Coahuila, with a branch from Cedros to Salverna, a total of 80 miles. Concessions granted to John Cooper through J. P. Taylor, of Mexico City. Contracts soon to be let and grading started within 6 months.